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BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

TREES AND SHRUBS FOR EVERY PURPOSE— WHERE TO BUY THEM

warf Conifers

ergreen Trees

warf Shrubs

wering Trees
and Shrubs

es and Shrubs
r Foliage and
Fruit

t of Nurseries

SPRING
1960

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NEW SERIES

. 16 NO. 1

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
BROOKLYN BOTANIC GARDEN
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Spring 1960

TREES AND SHRUBS FOR EVERY PURPOSE—WHERE TO BUY THEM

Each year thousands of questions come to the Botanic Garden and one of the most frequent queries is "Where can I buy . . .?" Partly in self-defense, our Editorial Committee conceived the idea of compiling this guide listing nearly 1,000 different species and varieties of the less usual trees and shrubs with nurseries where they can be purchased.

We wrote 130 nurseries in the several geographic areas of the United States and Canada, asking if they could supply plants and were willing to be included. Of these, 103 indicated their desire to cooperate and sent back carefully checked lists of plants they had in stock. No nursery was asked to pay for "advertising." This is strictly a Botanic Garden experiment to try to bring gardeners and nurserymen together.

There is no light reading here! This is a reference Handbook, nothing more, nothing less. And we ask only one cooperative gesture in return. A hundred or so plants have been listed with no sources indicated. Many of these seem to be available only from English or European firms but it is entirely possible that they are being grown in this country. If readers can tell us where these particular plants are to be found, possibly from small nurserymen who publish no catalogs, we would appreciate the information. It will help us to do a better job if we repeat the experiment some time in the future.

Please don't run from the scientific names in the lists, for common names are also included, and both common and scientific names are indexed for your convenience. Moreover, all the plants are grouped in a way that will help you find the species or varieties for any particular use. (See Contents, page 1).

Names of nurseries are listed at the back of the Handbook, beginning on page 64. Most of them are retail, a few are both wholesale and retail, but some are wholesale only. *Unless you are a nurseryman, please do not order from wholesale nurseries.* Ask your local dealer to put in an order for you. The cost to you will be no greater.

HOW TO USE THIS DIRECTORY: With the description of each plant, numbers or letters appear after "Sources." Turn to the list of nurseries for the numerical key. Wholesale and Canadian nurseries are indicated by letters.

Some of our nurserymen friends point out that not all the kinds of trees and shrubs listed here will be continuously available. Some will soon be sold out, probably by the end of June, and it may be necessary to wait another year for the things you want. Then, too, some nurseries may carry an occasional plant under one name, other nurseries under another. Generally this cannot be avoided.

Quite apart from the buying of plants, we feel almost certain that the book will be valuable in guidance for landscape planning.

Mr. Franz Eitel, formerly of the Botanic Garden staff, compiled the original lists of plants from which this Handbook was evolved. We were fortunate in securing the experienced plantsman, Curator Henry Teuscher of the Montreal Botanic Garden, to edit it and write the brief description of each plant.

May the usefulness of this "source book" measure up to our hopes. Your helpful criticism is solicited.

Sincerely yours,

George S. Avery

Director

PLANTS & GARDENS

VOL. 16 Spring, 1960 No. 1

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HENRY TEUSCHER, *Guest Editor*

CONSTANCE P. ELSON and the Editorial Committee
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DWARF CONIFERS

Those that are low-growing or slow-growing

Fir

Abies balsamea hudsonia
Spreading dwarf fir to 1 or 2 ft. Dark green. (Zone 3). Sources:

Abies balsamea nana
Densely bushy, slow-growing fir to 2 ft. Dark green. (Zone 3). Sources: 14, CAG.

Abies procera (nobilis) **glauca prostrata**
Prostrate to 2 or 3 ft. Grayish-blue. (Zone 4). Sources: 14.

False-Cypress

Chamaecyparis lawsoniana ellwoodi
Upright, conical, very slow growing to 3 or 5 ft. Grayish-blue. (Zone 6 to part Zone 5). Sources: 63, ORMN.

Chamaecyparis lawsoniana forsteckensis
Very broad conical, slow growing to 3 ft. Bluish-green. (Zone 6). Sources: 63, 102, ORMN, WBC.

Chamaecyparis lawsoniana minima
Densely broad conical, very slow growing to 2 or 2½ ft. Light green. (Zone 6). Sources: 75, WBC.

Chamaecyparis lawsoniana minima glauca
Upright broad conical, slow growing to 2½ ft. Steel-blue. (Zone 6). Sources: 43, 63, 102, MDTN, ORMN.

Chamaecyparis lawsoniana nana
Broadly globose, slow growing, eventually to 4 or 5 ft. Dark green. (Zone 6). Sources:

Chamaecyparis nootkatensis compacta
Dwarf Nootka Cypress
Densely bushy. Slow growing to 3 or 4 ft. Light green. (Zone 5 to part Zone 4). Sources: 14, ORMN.

Chamaecyparis obtusa coralliformis
Spreading with filiform, twisted branches to 1½ ft. Bluish-green. (Zone 5). Sources: 102, CAG.

Chamaecyparis obtusa lycopodioides aurea
Densely shrubby with irregularly divided crowded branches. Bright yellow. Very slow growing. Eventually to 3 ft. (Zone 5). Sources: CAG.

Chamaecyparis obtusa nana
Broadly globular, very slow growing to 2 ft. Dark green. (Zone 5 to part Zone 4). Sources: 102, CAG, ORMN.

Chamaecyparis obtusa nana aurea
Like **nana** but eventually to 4 or 5 ft. Young growth golden-yellow. (Zone 5). Sources: CAG.

Sources: see p. 64.

Chamaecyparis obtusa nana compacta
More densely compact than **nana**. Ve
slow growing to 2 ft. Fresh green. (Zo
5 to part Zone 4). Sources: 63.

Chamaecyparis obtusa nana gracilis (g
eilis nana)
Conical, slow growing, but eventually
5 ft. or more. Bright-green. (Zone
Sources: 6, 20, 22, 53, 54, 62, 63, 75, 91.

Chamaecyparis obtusa pygmaea (minim
Broadly globular, wood reddish-brow
twigs fan-shaped. Yellowish-green. Sl
growing, but eventually to 5 ft. (Zone
Sources: CAG.

Chamaecyparis pisifera filifera nana aur
(aurea nana)
Broadly cushion-shaped, very slow gro
ing to 2 ft., with thread-like golden-yell
branchlets. (Zone 4). Sources: CA
ORMN.

Chamaecyparis pisifera plumosa nana
(plumosa minima)
Round, bushy, slow growing to 2½
with lacy branchlets. Bluish-green. (Zo
4). Sources: 62, 102, MDTN, ORMN.

Chamaecyparis pisifera plumosa na
aurea (minima variegata, compressa na
aurea)
Round, bushy, slow growing to 2 ft., w
feathery branchlets, golden-yellow wh
young. (Zone 4). Sources: CAG, VAG

Chamaecyparis pisifera squarrosa nana
(pisifera nana)
Broadly cushion-shaped, very slow gro
ing to 2 ft. Bluish-green. (Zone
Sources: 28, 47, 63, MDTN, CAG.

Chamaecyparis pisifera squarrosa pygma
Still smaller, more compact and more b
ish than **squarrosa nana**. (Zone 4). Soure
20, 63, 102, MDTN, ORMN.

Chamaecyparis pisifera squarrosa pygma
aurea (pisifera nana aurea)
Like **squarrosa pygmaea** but young grow
golden-yellow. (Zone 4). Sources: 102.

Cryptomeria

Cryptomeria japonica globosa nana
Densely globular, slow growing to 3
light bluish-green. (Zone 5). Sources: CA

Cryptomeria japonica nana (lobbi na
monstrosa nana, pygmaea)
Irregularly cushion-shaped, slow growi
to 3 ft. Bluish-green. Sources: 63, 1
CAG, MDTN.

/ptomeria japonica vilmoriniana
ry dense, blunt conical, slow growing 2 or 2½ ft. Light green. Brownish in ter. (Zone 5). Sources: 63, MDTN.

Juniper

niperus chinensis japonica
reading shrub to 3 ft. Branches creep-, branchlets ascending. Fresh green. ne 4 to part Zone 3). Sources: MDTN.

niperus chinensis japonica aureo-varie-a
riegated yellow. (Zone 4). Sources: G.

niperus chinensis plumosa
reading shrub to 3 ft., branchlets form thery sprays. Dark green. (Zone 4). rces: OHH.

niperus chinensis sargenti
ostrate shrub to 2 ft. high and 10 ft. le. Light bluish-green. (Zone 4 to part ne 3). Sources: 28, 31, 36, 38, 49, 54, 71, 81, 91, 114, ILHD, OHH.

niperus communis compressa
nsely columnar, very slow growing to ft. Green. (Zone 5). Sources: 102, CAG.

niperus communis depressa (canadensis)
ostrate, forming broad patches, branches ending to 3 ft. Green. (Zone 3). rces: ILCF, ILHD.

niperus communis depressa aureo-spica rostrata aurea)
ung growth golden-yellow. (Zone 4). rces: CAG.

niperus communis saxatilis (alpina, ntana, nana)
one 4). Sources: 14, 102.

niperus conferta
PANESE SHORE JUNIPER
ostrate and creeping to 1 or 1½ ft. high. ung growth fresh green, later grayish-en. (Zone 5). Sources: 14, 38, 42, 66, IH.

niperus horizontalis
EEPING JUNIPER
ostrate with long creeping branches to 1 high. Grayish or bluish-green. (Zone 3). rces: 1, 22, 36, 37, 61, 114, OHH.

niperus horizontalis 'Bar Harbor'
rming dense mats, steel blue. (Zone 3). rces: 22, 36, 75, 81, 96, OHH.

niperus horizontalis douglasi
AUKEGAN JUNIPER
eeping, bluish-green in summer, purplish winter. (Zone 3). Sources: 31, 43, 61, , 114, ILHD.

niperus horizontalis glomerata
ry flat (8 inches) without long trailing anches. Bluish-green. (Zone 4). Sources: .

Juniperus horizontalis plumosa (communis depressa plumosa)
ANDORRA JUNIPER
Spreading and creeping, with feathery branchlets to 2 ft. high. Light green, purplish in fall. (Zone 4). Sources: 2, 42, 48, 49, 53, 74, 85, 86, 96, 112, 114, ILHD, IOS, MDTN, OHH.

Juniperus horizontalis prostrata (horizontalis procumbens, sabina prostrata)
Very flat, creeping to 10 ft. but barely 1 ft. high. Grayish-blue. (Zone 4). Sources: 47, CAG.

Juniperus procumbens
JAPANESE JUNIPER
Spreading with ascending branchlets to 1 or 2 ft. Bluish. (Zone 5 to part Zone 4). Sources: 45, 70, 88, ILHD, OHH.

Juniperus procumbens nana
Very dense and slow growing, hardly spreading. (Zone 4). Sources: 14, 20, CAG, ILHD.

Juniperus sabina tamariscifolia
Prostrate with partly upright branchlets to 2 ft. Bright green. (Zone 4). Sources: 28, 74, CAG, OHH, ORMN. Selected type: **'Grey Owl,'** Silvery-gray. Sources: CAG.

Juniperus squamata prostrata
Densely prostrate, spreading horizontally, less than 1 ft. high. Bright-green. Very handsome. (Zone 4). Sources: 75.

Juniperus virginiana reptans (virginiana horizontalis glauca)
Horizontally spreading, barely over 1 ft. high. Bright blue. (Zone 4). Sources: ILHD.

Spruce

Picea abies (excelsa) **echiniformis**
HEDGE-HOG SPRUCE
Cushion-forming, slow growing to 2 or 3 ft. Light green. (Zone 3). Sources: 102, CSN.

Picea abies gregoryana
Forming a very dense, round cushion. Very slow growing to 2 ft. Grayish-green. (Zone 3). Sources: 63, 71.

Picea abies maxwelli
Forming a dense, flat cushion, slow growing but eventually to 3 or 4 ft. Bright green. (Zone 3). Sources: 14, 31, 53, 57, 63, 75, 102, OHH.

Picea abies nana
Densely broad conical, very slow growing to 3 or 4 ft. (Zone 3). Sources: 31, OHH.

Picea abies nidiformis
Nest-shaped (without leader) to 3 ft. Green. (Zone 3). Sources: 1, 20, 28, 63, 74, 75, 91, 102, ILHD, MDTN.

Picea abies parsoni
Similar to **gregoryana** but less regular, to 2 or 3 ft. (Zone 3). Sources: 63.

Picea abies procumbens
Spreading flat horizontally, slowly growing to 3 or 4 ft. Light green. (Zone 3). Sources: 63, 102, OHH.

Picea abies pumila
Densely broad roundish to 3 ft. Dark green or bluish. (Zone 3). Sources: 31, 63, 71.

Picea abies repens
Prostrate, branches resting flat on each other to 1½ ft. Light green. (Zone 3). Sources: 63, 102, CSN.

Pine

Pinus mugo compacta
COMPACT MOUNTAIN PINE
Forming a dense round cushion, growing slowly to 4 or 5 ft. Dark green. (Zone 3). Sources: 75, ILHD.

Pinus strobus prostrata
Decumbent with trailing branches, grayish-green. (Zone 3). Sources: 14.

Yew

Taxus cuspidata densa
CUSHION YEW
Forming a dense cushion to 3 ft. or slightly more. Dark green. (Zone 4). Sources: 7, 47, 81, 91, MDTN, OHH.

Taxus cuspidata prostrata
With decumbent branches to 3 ft. Dark green. (Zone 4). Sources: 47, 97.

Arbor-Vitae

Thuja occidentalis pumila 'Little Gem'
Broadly globular to 5 ft. wide and 3 or 4 high. Dark green. (Zone 3). Sources: OHH.

Thuja occidentalis pygmaea 'Hetz's Mid
Densely broad globular, slow growing t or 2½ ft. (Zone 3). Sources: OHH, PA

Hiba Arbor-Vitae

Thujopsis dolabrata nana
DWARF HIBA ARBOR-VITAE
Densely bushy, slow growing to 3 or 4 Fresh green. (Zone 6). Sources: 63.

Hemlock

Tsuga canadensis hussi
Densely branched, broad conical to 3 (Zone 4). Sources: 63.

Tsuga canadensis minima
Densely globular with small needles, 2 t ft. (Zone 4). Sources: 63.

Tsuga canadensis minuta
Broadly globular, very slow growing. E tually to 1 ft. (Zone 4). Sources:

Tsuga canadensis parvifolia (microphy
Graceful with short branchlets and s needles. (Zone 4). Sources: 63, 114.

Tsuga canadensis prostrata
Completely prostrate. Light green. (Z 4). Sources: 63.

Picea abies gregoryana, a dwarf spruce, grows in dense round cushions

EVERGREEN TREES

Fir

ies concolor
LORADO FIR, WHITE FIR
'e to 75 ft. or more, needles bluish-green, nches long. (Zone 4). Sources: 28, 61, 63, 70, 76, 79, 81, OHH, PAFA.

ies concolor violacea
edles bluish-white, cones purple when mg. Sources: OHH.

ies cephalonica
EEK FIR
'e to 60 ft. or more, needles sharply nted, spreading. (Zone 5). Sources: 63.

ies firma
MI FIR
ee to 80 or 90 ft., needles stiff, 1½ inch g. (Zone 6 to part Zone 5). Sources: OHH.

ies homolepis
KKO FIR
ndsome tree to 65 ft. or more, needles ny green above, whitish underneath. one 4). Sources: OHH.

ies lasiocarpa arizonica
CKY MOUNTAIN FIR
ee to 45 ft. or more with corky, whitish rk, needles bluish above, whitish under- ath. (Zone 4 to part Zone 3). Sources: HH.

ies nordmanniana
RDMANN FIR
'ee to 100 ft. or more, needles shiny dark een above, whitish underneath. (Zone 4). urces: OHH.

ies pinsapo glauca
'ANISH FIR
'ee to 50 ft. or more, needles bluish, short d stiff. (Zone 6 to part Zone 5). Sources: , 28, 30, 63, 109, MDTN.

bies procera (nobilis)
OBLE FIR
'ee to 100 ft. or more, needles bluish- 'een. (Zone 5). Sources: 14, OHH.

bies veitchi
EITCH FIR
andsome tree to 50 ft. or more. Needles iny dark green above, white underneath. Zone 4 to part Zone 3). Sources: 28, 63, HH.

or other Firs, see Dwarf Conifers

Cedar

Cedrus atlantica
ATLAS CEDAR
Tree to 75 ft. or more, needles bluish-green. (Zone 6). Sources: 47, 62, 81, 86.

Cedrus atlantica glauca
BLUE ATLAS CEDAR
Needles silvery-blue. (Zone 6 to part Zone 5). Sources: 14, 20, 28, 29, 30, 32, 43, 50, 63, 81, 86, 109.

Cedrus atlantica glauca pendula
WEEPING BLUE ATLAS CEDAR
(Zone 6). Sources: 14.

Cedrus deodara
DEODAR CEDAR
Tree to 100 ft. Needles 2 inches long, dark bluish-green. (Zone 7 to part Zone 6). Sources: 12, 23, 32, 42, 50, 63, 66, 109, 112.

Cedrus libani
LEBANON CEDAR
Tree to 80 ft. or more, needles dark green. (Zone 5). Sources: 14, 32, 43, 62, 63, 66, 86, 109, OHH.

Cedrus libani pendula
WEEPING LEBANON CEDAR
Branches pendulous, needles rather long. (Zone 5). Sources: 14.

False-Cypress

Chamaecyparis lawsoniana
LAWSON CYPRESS
Tree to 100 ft. or more. Dark green. (Zone 5). Sources: 12, OHH.

Chamaecyparis lawsoniana allumi
COLUMNAR LAWSON CYPRESS
Bluish, columnar form. (Zone 6 to part Zone 5). Sources: 6, 20, 74, 81, OHH, PAFA.

Chamaecyparis lawsoniana glauca
BLUE LAWSON CYPRESS
(Zone 6 to part Zone 5). Sources:

Chamaecyparis lawsoniana gracilis
FOUNTAIN LAWSON CYPRESS
Form with pendulous branches. Bright green. (Zone 6 to part Zone 5). Sources: 6, 72.

Chamaecyparis nootkatensis
NOOTKA CYPRESS
Pyramidal tree to 75 ft. or more. Dark green, branchlets pendulous. (Zone 4). Sources: OHH.

Chamaecyparis nootkatensis pendula
Weeping Nootka Cypress
Tree with long hanging branchlets. (Zone 4). Sources: OHH.

Chamaecyparis obtusa
Hinoki Cypress
Tree to 75 ft. of rather slow growth. Requires acid soil. (Zone 4 to part Zone 3). Sources: 38, 47, 50, OHH.

Chamaecyparis obtusa gracilis
Slender Hinoki Cypress
Densely pyramidal tree to 45 ft. with pendulous branchtips. (Zone 4). Sources: 14, 18, 22, 54, 63, 66, OHH.

Chamaecyparis pisifera
Sawara Cypress
Pyramidal tree to 75 or 100 ft. Tolerates neutral and slightly alkaline soil. (Zone 3). Sources: 6, 28, 36, 37, 66, 71, 86, OHH.

Chamaecyparis pisifera aurea
Golden Sawara Cypress
Tree to 45 ft. with golden-yellow foliage. (Zone 4). Sources: OHH.

For other forms of Chamaecyparis, see Shrubs for Foliage and Dwarf Conifers.

Cryptomeria

Cryptomeria japonica
Tree to 75 ft. or more with stout, dark green foliage. (Zone 6 to part Zone 5). Sources: 28, 32, 43, 62, MDTN, OHH.

Cryptomeria japonica lobbi
Lobb's Cryptomeria
Dense, narrowly pyramidal tree to 50 ft. or more. Dark green. (Zone 6 to part Zone 5). Sources: 14, 29, 63, 91, OHH.

China-Fir

Cunninghamia lanceolata
Tree to 50 ft. with spreading branches. Sprouts from the stump if cut back. (Zone 7 to part Zone 6). Sources: 14, 43, 53, 63, 109.

Holly

Ilex aquifolium
English Holly
Tree to 35 ft. or more with shiny leaves and bright red berries. (Zone 6). Sources: 15, 30, 32, 62, 63.

Ilex aquifolium argenteo-marginata
Silver-Edge Holly
Tree to 25 or 30 ft. Leaves with white margins. (Zone 6). Sources: 15, 30, 43, 63, 105, 119.

Ilex aquifolium ferox
Hedgehog Holly
Tree to 30 ft. Leaves crisped and very spiny. (Zone 6). Sources: 15, 30, 63, 109.

Other varieties of English Holly: 14, 15, 30, 43, 63, 105, 109, 119, MDTN.

Ilex latifolia (tarajo)
Luster Leaf Holly, Tarajo
Tree to 35 ft. or more, with shiny leaves (Zone 7 to part Zone 6). Sources: 15, 30, 63, 119.

Ilex opaca
American Holly
Tree to 30 ft. or more. Leaves usually dull green, berries red. (Zone 5 to part Zone 4). Sources: 15, 30, 32, 45, 49, 57, 63, 79, 88, OHH.
Many named varieties
Sources: 15, 23, 32, 38, 42, 53, 63, 66, 89, 105, 109, 112, 114, 119, MDTN, OHH.

For other Hollies, see Shrubs for Foliage and Fruit.

Juniper, Red Cedar

Juniperus chinensis
Chinese Juniper
Tree to 45 ft. Grayish green. (Zone 4). Sources: OHH.

Juniperus chinensis keteleeri
Columnar Chinese Juniper
Densely columnar tree to 30 ft. Bluish green. (Zone 4). Sources: 91, ILHD, OHH.

Juniperus chinensis pyramidalis (columnaris)
Pyramidal Chinese Juniper
Compact, narrowly pyramidal or almost columnar tree to 45 ft. Bluish. (Zone 4). Sources: 1, 6, 43, 76, OHH.

Juniperus communis suecica
Swedish Juniper
Broadly columnar tree to 25 ft. Light green (Zone 4 to part Zone 3). Sources: OHH.

Juniperus rigida
Needle Juniper
Tree to 25 ft. or tall shrub with pendulous branchlets. (Zone 4). Sources: 47.

Juniperus scopulorum argentea
Western Red Cedar
Tree to 30 ft. Silver-blue. (Zone 4 to part Zone 3). Selected types: **'Chandler Blue'** Sources: 59, ILHD. **'Hill's Silver Glow'** Sources: ILHD.

Juniperus virginiana
Eastern Red Cedar
Tree to 60 ft. or more. Grayish to bluish green. (Zone 3 to part Zone 2). Sources: ILHD, OHH.

Juniperus virginiana canaerti
Canaert's Red Cedar
Densely pyramidal, dark green tree to 25 ft. (Zone 3 to part Zone 2). Sources: ILHD, OHH.

Juniperus virginiana fastigiata (eupressifolia)
Columnar to narrowly pyramidal tree to 25 ft., bluish-green. (Zone 3). Sources: ILHD

niperus virginiana glauca
.VER RED CEDAR
ee to 25 or 30 ft. Silvery-blue. (Zone 3 part Zone 2). Sources: ILHD, OHH.
lected type: **burki**
ee to 15 or 20 ft. Darker blue and more npact. Sources: 6, 36, 43, 48, 49, 53, 59, . 70, 80.

niperus virginiana pendula
EEPING RED CEDAR
ee to 25 ft. or more. Branches spreading, anchlets pendulous. (Zone 3). Sources: 14.

niperus virginiana pyramidiformis
illi)
ILL'S PYRAMIDAL RED CEDAR
nsely pyramidal tree to 20 ft. or more. ayish-green. (Zone 3). Sources: 48, 49, , ILHD.

niperus virginiana schotti
arrowly pyramidal tree to 20 ft. or more. right green. (Zone 3). Sources: OHH.

or other Junipers, see Shrubs Planted r Foliage and Dwarf Conifers

Incense-Cedar

ibocedrus decurrens
arrowly pyramidal tree to 100 ft. Dark een. (Zone 6 to part Zone 5). Sources: 4, 32, 43, 63, 109, MDTN.

Magnolia

Iagnolia grandiflora
OUTHERN MAGNOLIA
andsome tree to 75 ft. with large leaves nd large fragrant white flowers. (Zone 7). ources: Available at most nurseries in the outh.

Photinia

'hotinia serrulata
'HINESE PHOTINIA
'ree to 20 ft. or tall shrub with large, hiny leaves, attractive white flowers and right red berries. (Zone 7). Sources: 12, 0, 32, 38, 42, 50, 66, 81, 109.

Spruce

Picea abies (excelsa)
NORWAY SPRUCE
Tree to 100 ft. or more. Dark green. (Zone 2). Sources: ILHD, OHH.

Picea abies aurea
YELLOW NORWAY SPRUCE
Tree to 30 or 40 ft. Needles golden-yellow. (Zone 3). Sources: OHH.

Picea abies pendula
WEEPING NORWAY SPRUCE
Tree to 40 or 50 ft. with upright leader and pendulous branches and branchlets. (Zone 2). Sources: OHH.

Picea asperata
DRAGON SPRUCE
Densely pyramidal tree to 60 ft. Dark green. (Zone 4). Sources: 61, OHH.

Picea engelmanni
ENGELMANN'S SPRUCE
Densely pyramidal tree to 100 ft. or more. Bluish-green. (Zone 3 to part Zone 2). Sources: 90, OHH, PAFA.

Picea glauca (canadensis) **densata**
BLACK HILL SPRUCE
Slow-growing densely pyramidal tree to 40 ft. or more. Usually bluish-green. (Zone 3). Sources: 43, 49, 76, 79, 86, 96, 112, OHH, PAFA.

Picea omorika
SERBIAN SPRUCE
Pyramidal tree to 75 ft. Needles shiny dark green on one side, bluish-white on the other. (Zone 4 to part Zone 3). Sources: 6, 14, 28, 61, 63, 79, 81, 91, 109, OHH.

Picea orientalis
ORIENTAL SPRUCE
Densely branched tree to 75 ft. or more, with glossy, dark green needles. (Zone 4). Sources: 28, 63, 81, 91, OHH.

Picea pungens
COLORADO SPRUCE
Tree to 80 ft. or more. More or less bluish-green. (Zone 3 to part Zone 2). Sources: ILHD, OHH, PAFA.

Picea pungens glauca
BLUE COLORADO SPRUCE
Tree to 75 ft. Steel blue. (Zone 3).
Selected types: **'Koster'**
KOSTER'S BLUE COLORADO SPRUCE
Sources: 91, ILHD.
'Moerheimi'
Silver-blue. Sources: 94, OHH.

Picea pungens glauca pendula
WEEPING BLUE COLORADO SPRUCE
(Sold by nurseries also as **P. pungens kosteriana** which causes confusion with Koster's Blue Colorado Spruce)
Tree to 60 ft. or more. Leading shoot upright. Branches and branchlets pendulous. Steel blue. (Zone 3). Sources: CSN.

Picea wilsoni
WILSON'S SPRUCE
Densely conical tree to 50 ft. or more. Dark green. (Zone 5 to part Zone 4). Sources: OHH.

For other Spruces, see Shrubs Planted for Foliage and Dwarf Conifers.

Pine

Pinus bungeana
LACEBARK PINE
Slow-growing tree to 40 or 50 ft. Bark peeling off in patches. (Zone 4). Sources: 14, 109, OHH.

Pinus cembra
SWISS STONE PINE
Densely pyramidal, slow-growing tree to 50 ft. Dark green. (Zone 3). Sources: 28, 29, 63, 114, OHH.

Pinus densiflora
JAPANESE RED PINE
Graceful tree to 60 ft. Needles light bluish-green. (Zone 4). Sources: OHH.

Pinus griffithi (excelsa)
HIMALAYAN PINE
Handsome tree to 75 ft. or more with long, drooping, bluish-gray needles. (Zone 5 to part Zone 4). Sources: 28, 63, MDTN.

Pinus koraiensis
KOREAN PINE
Pyramidal tree to 50 ft. or more. Dark green. (Zone 4 to part Zone 3). Sources: 63, OHH.

Pinus nigra austriaca
AUSTRIAN PINE
Tree to 75 ft. or more with spreading branches and stiff, dark green needles. (Zone 3). Sources: 22, ILHD, OHH.

Pinus parviflora
JAPANESE WHITE PINE
Densely pyramidal tree to 45 ft. or more. Bluish-green. (Zone 5 to part Zone 4). Sources: 14, OHH.

Pinus peuce
MACEDONIAN PINE
Graceful, narrowly pyramidal tree to 40 ft. or more. Light green. (Zone 4 to part Zone 3). Sources: 61, OHH.

Pinus ponderosa scopulorum
(Form of) WESTERN YELLOW PINE
Densely branched tree to 30 ft. or more, with stiff, dark green needles. (Zone 4). Sources:

Pinus resinosa
RED OR NORWAY PINE
Tree to 75 ft. or more with spreading branches. Light green. (Zone 2). Sources: 1, 22, 43, 48, 61, 62, 76, 79, 81, 85, 109, 114, OHH.

Pinus strobus
WHITE PINE
Tree to 75 ft. or more. Pyramidal when young. Bluish-green. (Zone 3 to part Zone 2). Sources: 22, OHH, PAFA.

Pinus strobus fastigiata
PYRAMIDAL WHITE PINE
Tree to 75 ft. or more with ascending branches. Bluish-green. (Zone 3). Sources: 14, 63.

Pinus sylvestris
SCOTS PINE
Tree to 75 ft. Grayish-green. Picturesq
when old. (Zone 2). Sources: ILHD, OH
PAFA.

Pinus thunbergi
JAPANESE BLACK PINE
Tree to 60 ft. with spreading branch
Dark green. (Zone 4). Sources: 6, 18, 2
28, 47, 54, 61, 62, 63, 71, 81, 91, 114, OH

For other forms of Pines see, Shrubs f
Foliage and Dwarf Conifers

Douglas Fir

Pseudotsuga taxifolia (douglasi) **glauca**
ROCKY MOUNTAIN DOUGLAS FIR
Graceful tree to 80 ft. or more. More
less bluish-green. (Zone 4 to part Zone 3
Coastal form is more tender. (Zone 6
Sources: 14, 36, 54, 70, 71, 76, 79, 90, 11
PAFA.

Pseudotsuga taxifolia glauca pendula
WEEPING DOUGLAS FIR
Tree to 50 ft. with pendulous branch
Bluish-green. (Zone 4). Sources: 14.

Umbrella-Pine

Sciadopitys verticillata
Pyramidal tree to 70 ft. or more, with lon
whorled needles. Glossy dark green. (Zo
5 to part Zone 4). Sources: 14, 28, 6
MDTN.

Sequoia

Sequoiadendron giganteum
GIANT SEQUOIA
Pyramidal tree to 200 ft. or more. Needl
flat, spreading in two ranks. (Zone 6
Sources: 43.

Yew

Taxus baccata
ENGLISH YEW
Tree to 40 ft. or more. Dark green. (Zo
6 to part Zone 5). Sources: 12, 32, 5
OHH.

Taxus baccata stricta (fastigiata)
IRISH YEW
Densely columnar tree to 10 or 12 ft. (Zo
6). Sources: 32, OHH.

Taxus cuspidata (var. capitata)
JAPANESE YEW
Tree to 40 ft. with spreading branch
Dark green. (Zone 4). Sources: 6, 7, 28, 3
37, 47, 49, 54, 60, 62, 70, 71, 74, 79, 81, 9
OHH.

For other forms of Yews, see Shrubs f
Foliage and Dwarf Conifers.

Arbor-Vitae

Thuja occidentalis
American Arbor-Vitae
Pyramidal tree to 50 ft. (Zone 2). Sources: LHD, OHH.

Thuja occidentalis 'Columbia'
Columnar Arbor-Vitae
Tree to 45 ft. densely columnar. (Zone 3). Sources: OHH.

Thuja occidentalis douglasi aurea
Golden Douglas Arbor-Vitae
Slender conical tree to 40 ft. Golden yellow. (Zone 3). Sources: 96, OHH.

Thuja occidentalis douglasi pyramidalis
Pyramidal Douglas Arbor-Vitae
Narrowly pyramidal or columnar tree to 40 ft. Fresh green. (Zone 3). Sources: 12, 31, 50, 54, 61, 71, 81, 114.

Thuja occidentalis fastigiata (columnaris, trieta, pyramidalis)
Columnar Arbor-Vitae
Columnar tree to 40 ft. Light green. (Zone 3). Sources: 43, 71, 76, 86, OHH.

Thuja occidentalis lutea (elegantissima) **George Peabody'**
Golden Arbor-Vitae
Slender conical tree to 20 ft. Golden yellow. (Zone 3). Sources: 6, 48, 66, 114, OHH.

Thuja occidentalis nigra
Wintergreen Arbor-Vitae
Pyramidal tree to 30 ft. or more. Does not discolor in winter. (Zone 3). Sources: OHH.

Thuja occidentalis spiralis
Slender pyramidal tree to 25 or 30 ft. Branches spirally twisted. Branchlets fern-like. Bluish-green. (Zone 3). Sources: OHH.

Thuja occidentalis robusta (wareana)
Ware's Arbor-Vitae
Densely pyramidal tree to 15 or 20 ft. Bright green. (Zone 3). Sources: 22, OHH.

Thuja orientalis
Oriental Arbor-Vitae
Pyramidal tree to 20 ft. Fresh green. (Zone 6 to part Zone 5). Sources: 43, 53, OHH.

Thuja orientalis conspicua
Densely fastigiate tree to 15 ft. Green with golden yellow tips. (Zone 6). Sources: OHH.

Thuja plicata
Giant Arbor-Vitae
Fast-growing tree to 100 ft. or more, with shiny, bright green leaves. (Zone 5 to part Zone 4). Sources: 31, 90, OHH.

Thuja plicata atrovirens
Dark Green Giant Arbor-Vitae
Tree to 75 ft. or more. Dark green. (Zone 4). Sources: 36, OHH.

Thuja plicata fastigiata
Columnar Giant Arbor-Vitae
Densely columnar tree to 75 ft. (Zone 5). Sources: OHH.

Thuja standishi
Japanese Arbor-Vitae
Tree to 40 ft. with spreading branches. Green. (Zone 5). Sources: OHH.

For other forms of Arbor-Vitae, see Shrubs for Foliage and Dwarf Conifers.

Thujopsis

Thujopsis dolabrata
Hiba Arbor-Vitae
Tree to 30 ft. or tall shrub with spreading branches. (Zone 6). Sources:

Hemlock

Tsuga canadensis
Graceful tree to 50 ft. or more. Dark green. (Zone 4 to large parts of Zone 3). Sources: Commonly available.

Tsuga canadensis atrovirens
Dark Green Common Hemlock
Densely pyramidal tree to 30 ft. Very dark green. (Zone 4). Sources: 63.

Tsuga canadensis pendula (sargentiana)
Weeping Hemlock
Tree of irregular shape to 15 ft. or more with pendulous branches. (Zone 4). Sources: MDTN. Fairly generally available in nurseries of the northeast.

Tsuga caroliniana
Carolina Hemlock
Densely pyramidal tree to 50 ft. (Zone 4). Sources: 22, 47, 61.

Tsuga diversifolia
Japanese Hemlock
Graceful tree to 50 ft. (Zone 5). Sources: 14, 31, 47, 63.

Tsuga heterophylla
Western Hemlock
Graceful, narrowly pyramidal tree to 100 ft. Requires a humid climate. (Zone 5). Sources: 90.

Tsuga mertensiana
Mountain Hemlock
Tree to 60 ft. or more with slender pendent branches. (Zone 6 to part Zone 5). Sources: 14, 43, 90.

Tsuga sieboldi
Siebold's Hemlock
Tree to 20 or 25 ft. with spreading branches. Sometimes shrubby. (Zone 6 to part Zone 5). Sources: 28, 63.

DWARF OR LOW-GROWING SHRUBS

Deciduous and Broadleaf-Evergreen

Abelia

Abelia grandiflora nana (prostrata)
Evergreen, partly prostrate shrub to 2 or 3 ft. Flowers pinkish, showy. June-September. (Zone 5). Sources: MDTN.

Spine-Pink

Acanthophyllum pungens (spinosum)
Forming tight cushions to 4 or 5 inches. Leaves evergreen, spiny. Flowers pale pink, fragrant. (Zone 5). Sources: 102, CAG.

Andromeda

Andromeda glaucophylla
Bog-Rosemary
Creeping evergreen shrub to 6 or 8 inches. Leaves silvery-blue beneath. Flowers pink. May-July. Requires moist, acid soil. (Zone 2). Sources: CAG.

Andromeda polifolia minima (nana compacta)
Evergreen, forming a dense cushion to 4 inches. Flowers pink, showy. May-June. Requires acid soil. (Zone 4). Sources: 102, CAG.

Andromeda polifolia nana (grandiflora compacta)
Evergreen, more or less upright to 8 or 10 inches. Flowers pink, showy. May-June. (Zone 4). Sources: 75, 102, CAG.

Arcterica

Arcterica, see **Pieris nana**

Bear-Berry

Arctostaphylos uva-ursi
Evergreen trailing shrub to 1 ft., with rooting branches and bright green leaves. Prefers sandy soil. (Zone 2). Sources: 31, 47, 61, 62, 75, 114, CAG.

Barberry

Berberis buxifolia nana
Dwarf Magellan Barberry
Compact evergreen, spiny shrub to 3 ft. Leaves bright green, spiny pointed. (Zone 6 to part Zone 5). Sources: 75.

Berberis julianae nana
Compact evergreen shrub to 3 or 4 ft. Leaves dark green, spiny. (Zone 5). Sources: 81, MDTN.

Berberis stenophylla compacta
Evergreen compact shrub to 2 or 3 f
Berries orange-red. (Zone 6). Source
CAG.

Berberis thunbergi atropurpurea na
'Crimson Pygmy'
Deciduous compact shrub to 2 ft. Leav
purplish red. Excellent for low hedg
(Zone 5 to part Zone 4). Sources: 2
37, 49, 70, 81, 113.

Berberis thunbergi minor
Deciduous compact shrub to 1 or 1½ f
Leaves small, bright green. Excellent f
low hedges. (Zone 4). Sources: OHH.

Spike-Heath

Bruckenthalia spiculifolia
Upright evergreen shrub to 10 or 12 inche
Flowers pink in upright racemes. Jun
August. Same requirements as Heathe
(Zone 5). Sources: 75.

Boxwood

Buxus microphylla compacta
Compact evergreen shrub. Slow growing
1½ or 2 ft. (Zone 5). Sources: 32, 63, 7
102, 109, MDTN.

Buxus microphylla koreana
Korean Boxwood
Spreading evergreen shrub, slow growi
to 1½ or 2 ft. Useful for edging. (Zo
4). Sources: 31, 61, 62, 63, 75, 94, OH

Buxus microphylla sinica (harlandi)
Densely compact evergreen shrub to 2 f
with narrow leaves. (Zone 6). Source
MDTN.

Buxus sempervirens myrtifolia
Myrtle-Leaf Boxwood
Dense evergreen shrub. Slow growing to
ft. with small, round leaves. (Zone 6
part Zone 5). Sources: 63.

Buxus sempervirens rosmarinifolia
Rosemary-Leaf Boxwood
Evergreen shrub to 4 ft. with small, narro
leaves. (Zone 6). Sources: 63.

Buxus sempervirens suffruticosa
Edging Boxwood
Evergreen shrub to 2 or 2½ ft. wit
roundish, glossy dark green leaves. (Zon
5). Sources: MDTN, OHH.

Heather

Calluna vulgaris foxi
DWARF HEATHER
Evergreen. Forming dense cushions to 4 or 5 inches high. Flowers purple. August-September. (Zone 4). Sources: 75, 102, CAG.

Calluna vulgaris nana (minima)
Evergreen. Mat-forming to 3 or 4 inches high. Flowers purple. August-September. (Zone 4). Sources: 75, CAG.

Calluna vulgaris pygmaea
Evergreen. Mat-forming to 3 or 4 inches high. Flowers pinkish-lavender. June-July. (Zone 4). Sources: CAG.

Flowering Quince

Chaenomeles japonica alpina
DWARF JAPANESE FLOWERING QUINCE
Deciduous shrub with procumbent branches and ascending branchlets to 3 ft. Flowers vermilion. April-May. (Zone 4 to part Zone 3). Sources 67, 101, 109, OHH.
Selected type: **'Knaphill'**
Sources: 113.

Chaenomeles superba pygmaea (C. lagenaria pygmaea)
Dense deciduous shrub to 3 or 4 ft. Flowers blood-red. April-May. (Zone 4). Sources: OHH, VAGR.

Rock-Rose

Cistus villosus prostratus
DWARF ROCK-ROSE
Evergreen prostrate shrub, forming a mound of 1 foot. Leaves grayish-green Flowers white. June-July. (Zone 6 to part Zone 5). Sources: 102.

Dogwood

Cornus stolonifera kelseyi (nana)
Dense deciduous shrub with slender branches. 2 to 2½ ft. Excellent for low hedges. (Zone 3). Sources: 61.

Cotoneaster

Cotoneaster adpressa
CREEPING COTONEASTER
Prostrate deciduous shrub to 6 inches. Branches closely appressed to the ground. Berries bright red. (Zone 4 to part Zone 3). Sources: 12, 14, 31, OHH.

Cotoneaster adpressa praecox
More vigorous, forming a mound of 1½ to 2 ft. (Zone 4 to part Zone 3). Sources: 14, 18, 22, 61, 91, 93, 114.

Cotoneaster adpressa 'Tom Thumb'
Very compact, hardly creeping at all, to 8 or 10 inches. (Zone 4 to part Zone 3). Sources:

Cotoneaster apiculata
CRANBERRY COTONEASTER
Deciduous shrub with horizontally spreading branches to 3 or 4 ft. Leaves glossy dark green. Berries rather large, glossy crimson. (Zone 4). Sources: 14, 22, 43, 48, 63, 81, 91, 94, 113, 114, OHH.

Cotoneaster buxifolia vellaea
BOXLEAF COTONEASTER
Evergreen prostrate shrub to 1 ft. Berries red. (Zone 7 to part Zone 6). Sources: 118.

Cotoneaster congesta (microphylla glacialis)
Evergreen trailing shrub. Leaves whitish beneath. Berries bright red. (Zone 6). Sources: 63, 75, CAG.

Cotoneaster conspicua decora (C. decora)
NECKLACE COTONEASTER
Evergreen prostrate shrub with ascending branches to 2 ft. Berries scarlet, freely produced. (Zone 7 to part Zone 6). Sources: MDTN.

Cotoneaster dammeri (humifusa)
BEARBERRY COTONEASTER
Evergreen shrub to 1 ft. with long trailing and rooting branches. Leaves glossy dark green. Berries red. (Zone 4). Sources: 12, 14, 50, 63, 75, 102, OHH.

Cotoneaster horizontalis
ROCKSPRAY COTONEASTER
Deciduous or half-evergreen shrub to 2 or 2½ ft. With horizontally spreading branches. Leaves turn red and orange in fall. Berries small, bright red. (Zone 4). Sources: OHH.

Cotoneaster horizontalis 'Little Gem'
Forming a tight mound of 6 or 8 inches, hardly spreading. Sources: 75.

Cotoneaster horizontalis perpusilla
More depressed than *C. horizontalis*. To 10 inches. Sources: 62, NJJV.

Cotoneaster microphylla
SMALL-LEAF COTONEASTER
Dense evergreen shrub to 2 or 2½ ft. Leaves small, glossy dark green. Berries scarlet. (Zone 6 to part Zone 5). Sources: 12, 61, 63, 86, OHH.

Cotoneaster microphylla thymifolia
With narrow leaves. To 2 ft. (Zone 5). Sources: 75, 102.

Broom

Cytisus ardoini
Decumbent deciduous shrub to 8 or 9 inches. Flowers golden-yellow. April-May. (Zone 7 to part Zone 6). Sources: 102.

Cytisus beani (ardoini x purgans)
Semiprostrate deciduous shrub to 1 or 1½ ft. Flowers bright yellow. April-May. (Zone 5). Sources:

Cytisus decumbens (Genista decumbens)
Prostrate deciduous shrub to 8 or 9 inches. Flowers bright yellow. May-June. (Zone 5 to part Zone 4). Sources: 75, 102.

Cytisus diffusus (Genista humifusa)
Prostrate, deciduous, slow growing to 9 or 10 inches. Flowers deep yellow. May-June. (Zone 5 to part Zone 4). Sources: 102.

Cytisus kewensis (ardoini x multiflorus)
Low spreading deciduous shrub to 1 ft. Flowers creamy-white. May. (Zone 6). Sources: 12, 62, 75.

Cytisus purgans
Dense, deciduous shrub to 2 or 3 ft. Flowers bright yellow. May-July. (Zone 5). Sources: 14, 31, 75.

Cytisus purpureus
PURPLE BROOM
Spreading deciduous shrub to 1½ ft. Flowers purple. May-June. (Zone 4). Sources: 63, 75, 102.

Cytisus purpureus albus
Flowers white. (Zone 3). Sources: CMD.

Cytisus purpureus albo-carneus (roseus)
Flowers pale pink. (Zone 5). Sources:

Daphne

Daphne blagayana
Evergreen more or less prostrate shrub to 8 inches. Flowers white, fragrant. March-May. (Zone 6 to part Zone 5). Sources: 102, CAG.

Daphne cneorum
GARLAND DAPHNE
Evergreen, forming a dense mound to 8 or 12 inches. Flowers pink, fragrant. April-May. (Zone 3). Sources: 113, CAG, OHH.

Daphne collina
Dense evergreen shrub to 2 or 2½ ft. Leaves dark green. Flowers rose-purple, fragrant. June-July. (Zone 7 to part Zone 6). Sources: 102.

Daphne retusa
Dense evergreen shrub to 2 or 2½ ft. Leaves glossy green. Flowers white, flushed rose, fragrant. May. (Zone 6 to part Zone 5). Sources: CAG.

Daphne tangutica
Similar to *D. retusa*, to 1½ or 2 ft. Flowers flushed rose, fragrant. May. (Zone 5 to Zone 3 (with protection)). Sources: CMD.

Mountain-Avens

Dryas drummondi
AMERICAN MOUNTAIN-AVENS
Mat-forming evergreen shrub to 4 inches. Flowers nodding, pale yellow. May-July. (Zone 3). Sources: 75, CAG.

Dryas octopetala
MOUNTAIN-AVENS
Mat-forming evergreen shrub to 4 or 5 inches. Flowers upright, white. May-July. Seed heads conspicuous. (Zone 2 to Zone 1). Sources: CAG.

Dryas octopetala lanata (minor)
Dwarfer. Leaves silvery-gray. Sources: 102, CAG.

Dryas suendermanni (octopetala x drummondi)
Flowers slightly nodding. Yellow in bud, later white. (Zone 3). Sources: 102.

Trailing Arbutus

Epigaea asiatica
JAPANESE TRAILING ARBUTUS
Long trailing evergreen shrub to 5 or 6 inches. Flowers fragrant. April-May. (Zone 5 to part Zone 4). Sources: CAG.

Epigaea repens
AMERICAN TRAILING ARBUTUS
Long trailing evergreen shrub to 5 or 6 inches. Flowers pink, very fragrant. April-May. (Zone 3). Sources: 75, 102, CAG.

Heath

Erica carnea 'Springwood White'
Almost prostrate, flowers white. (Zone 4). Sources: 75, CAG.

Erica carnea 'Vivelli'
Almost prostrate, flowers carmine. (Zone 4). Sources: 75, CAG.

Erica ciliaris 'Dawn'
Almost prostrate, flowers rich pink. (Zone 6). Sources: CAG.

Erica cinerea 'C. D. Eason'
Dwarf and compact. Flowers bright red. (Zone 5). Sources: ORMN.

Erica cinerea 'Golden Drop'
Prostrate. Leaves golden yellow, flowers lilac. (Zone 6). Sources: CAG, ORMN.

Erica vagans nana
Very dwarf, spreading. Flowers white (Zone 5). Sources: ORMN.

Escallonia

Escallonia langleyensis nana (E. rubra nana, E. rubra pygmaea)
Decumbent and spreading half-evergreen shrub to 1 ft. Flowers rosy-red. July-August (Zone 7 to part Zone 6). Sources: CAG.

Euonymus

Euonymus fortunei (radicans acuta)
WINTER CREEPER
Trailing and rooting or climbing evergreen shrub. Leaves glossy dark green. (Zone 5 to part Zone 4). Sources: 113, OHH.

nymus fortunei colorata
iling to 1½ or 2 ft. high. Leaves turn
c purple in fall. (Zone 4). Sources:
H.

nymus fortunei kewensis
, creeping evergreen with small leaves.
ne 4). Sources: 102, 113.

nymus nana
f-evergreen procumbent shrub to 2 ft.
its pink, showy. (Zone 3). Sources:
D.

nymus nana turkestanica
re vigorous and more upright to 3 ft.
ne 3). Sources: CMD.

nymus obovata
iduous or half-evergreen procumbent
ub to 1 ft. Fruits crimson, warty. (Zone
Sources: CMD.

nymus obovata variegata
ves variegated white, pinkish in fall.
rees: 102.

Forsythia

rsythia 'Arnold Dwarf'
strate, valuable as a deciduous ground
er, to 1 ft. Flowers sparsely. April-May.
ne 4). Sources: 43, 62, 63, 80, 114.

rsythia viridissima 'Bronx'
rming green mats to 10 inch. high.
wers sparsely. Sources: 36, 63.

Fuchsia

chsia magellanica riccartoni
aceful shrub to 2½ or 3 ft. with slender,
rple and scarlet flowers. June-September.
one 7 to part Zone 6). Sources: CAG.

chsia magellanica pumila
re compact, to 1 ft. (Zone 7 to part
ne 6). Sources: CAG.

Wintergreen

ultheria humifusa
ESTERN WINTERGREEN
ergreen, mat-forming shrub to 4 inches.
rries scarlet. (Zone 5). Sources: 102.

ultheria miqueliana
reading evergreen shrub to 1 ft. Leaves
n crimson in fall. Flowers white, showy.
ne-July. Berries white. (Zone 6 to part
ne 5). Sources: 102.

aultheria nummularioides
railing evergreen shrub to 4 inches high.
rries blue-black. (Zone 7 to part Zone
. Sources: 102.

aultheria procumbens
ASTERN WINTERGREEN
vergreen creeping shrub forming mats
ith glossy leaves and bright red berries.
Zone 3). Sources: 102, CAG.

Huckleberry

Gaylussacia brachycera
BOX HUCKLEBERRY
Evergreen, spreading shrub to 1½ ft. Leaves glossy green. (Zone 6). Sources: 14, 75.

Broom

Genista horrida
Densely cushion-forming, very spiny shrub to 10 or 12 inches. Grayish-green. Flowers yellow. June-August. (Zone 6). Sources: 102.

Genista pilosa
Prostrate shrub to 8 or 10 inches high. Flowers yellow in racemes. June-July. (Zone 5 to part Zone 4). Sources: 31, 75, CAG.

Genista sagittalis
Flatly prostrate shrub to 6 or 8 inches high. Fresh green. Flowers yellow. June. (Zone 4 to part Zone 3). Sources: 75, CAG.

Genista silvestris pungens (G. dalmatica)
Densely branched, spiny shrub to 6 or 8 inches. Flowers yellow. May-June. (Zone 7 to part Zone 6). Sources: 102, CAG.

Genista villarsi
Slow-growing prostrate shrub to 5 or 6 inches. Flowers golden-yellow. June-July. (Zone 5). Sources: CAG.

False Sun-Rose

Halimium lasianthum
Upright evergreen shrub to 2 or 3 ft. Leaves grayish. Flowers 1½ inch across, yellow with purple blotches at base. May-June. (Zone 7). Sources: 102.

Veronica

Hebe (Veronica) **'Alicia Amherst'** (hybrid of *H. speciosa*)
Dense evergreen shrub to 1½ or 2 ft. Flowers deep purple. June-July. (Zone 7). Sources:

Hebe (Veronica) **cupressoides nana**
Compact-globose evergreen shrub to 1 or 1½ ft. Flowers pale blue. June-July. (Zone 7 to part Zone 6). Sources: 75.

Hebe (Veronica) **hectori**
Upright evergreen shrub to 2 or 2½ ft. Leaves glossy light green. Flowers white or pinkish. (Zone 7). Sources: ORMN.

Sun-Rose

Helianthemum nummularium (vulgare)
Evergreen or half-evergreen, prostrate, to 8 or 12 inches high. Flowers May-July. Many named varieties with yellow, pink, orange or crimson, single or double flowers. (Zone 4). Sources: CAG.

St. Johnswort

Hypericum buckleyi
BUCKLEY'S ST. JOHNSWORT
Dense shrublet to 8 or 10 inches. Leaves grayish. Flowers bright yellow. June-July. (Zone 5). Sources:

Holly

Ilex crenata 'Green Cushion'
Prostrate evergreen shrub to 8 or 10 inches. Glossy dark green. (Zone 6 to part Zone 5). Sources: MDTN.

Ilex crenata 'Stokes Dwarf'
Sources: 23, 91.

Jasmine

Jasminum parkeri
Half-evergreen shrub to 2 or 3 ft. Stems green. Leaves pinnate. Flowers yellow. June-July. (Zone 7). Sources: 102.

Bog Laurel

Kalmia polifolia microphylla
Densely branched evergreen shrub to 8 or 10 inches. Leaves narrow. Flowers pink. May-June. (Zone 3). Sources: 75.

Kalmiopsis

Kalmiopsis leachiana
Upright evergreen shrub to 10 or 12 inches. Leaves glossy dark green. Flowers rosy-purple. June. (Zone 6 to part Zone 5). Sources: CAG.

Sand-Myrtle

Leiophyllum buxifolium
BOX SAND-MYRTLE
Upright evergreen shrub to 1½ ft. Leaves glossy green. Flowers white. June-July. (Zone 5). Sources: 14, 65, 88.

Leiophyllum buxifolium prostratum (nanum)
More or less prostrate to 10 inches. (Zone 5). Sources: CAG.

Leucothoe

Leucothoe catesbaei nana
Evergreen shrub to 2 or 2½ ft. with reddish branches and glossy green leaves. (Zone 4). Sources: 62, MDTN.

Leucothoe davisiae
Evergreen shrub to 1½ or 2 ft. Leaves glossy dark green. Flowers white in upright panicles. June. (Zone 6 to part Zone 5). Sources: 102.

Leucothoe keiskei
Graceful, procumbent evergreen shrub to 1 or 1½ ft. White flowers showy. July. (Zone 5). Sources: CAG.

Gromwell

Lithospermum diffusum (prostratum)
Evergreen shrublet to 6 or 10 inches, forming mats. Flowers bright blue. May-June (Zone 6). Named types: **'Heavenly Blue'** and **'Grace Ward.'** Sources: CAG.

Alpine-Azalea

Loiseleuria procumbens
More or less prostrate evergreen shrub to 4 or 6 inches. Flowers pink. June-July (Zone 2). Sources: 75, CAG.

Mahonia

Mahonia nervosa
Evergreen shrub to 1½ ft. Leaves glossy green. Flowers bright yellow. May-June (Zone 5). Sources: 14, 75.

Mahonia repens
Creeping evergreen shrub to 1 ft. Leaves dull green. (Zone 4). Sources: 90, OHH.

Partridge Berry

Mitchella repens
Trailing evergreen shrublet to 10 or 12 inches. Berries bright scarlet. (Zone 3). Sources: 85, 88.

Osmanthus

Osmanthus delavayi, see **Siphonosmanthus**

Pachistima

Pachistima canbyi
Dense evergreen shrub to 1 ft. Leaves narrow, glossy green. Useful for edging or ground cover. (Zone 4). Sources: 7, 13, 31, 37, 61, 62, 75, 113, OHH.

Pachysandra

Pachysandra terminalis
JAPANESE SPURGE
Creeping, evergreen shrublet to 8 or 10 inches. Fresh green. Useful ground cover. (Zone 4). Sources: Commonly available.

Penstemon

Penstemon cardwelli (fruticosus)
Semievergreen shrub to 10 or 12 inches. Flowers purple. July-August. (Zone 6). Sources: CAG.

Penstemon davidsoni
Semievergreen, procumbent to 8 inches. Flowers lavender. June-July. (Zone 7 to part Zone 6). Sources:

Penstemon menziesi
Semievergreen to 8 inches. Flowers purplish-blue. July-August. (Zone 5 to part Zone 4). Sources: CAG.

Penstemon newberryi
Semievergreen to 12 or 15 inches. Flowers rose or carmine. July-September. (Zone 6). Sources: CAG.

:nstemon scouleri
mievergreen shrub to 10 or 12 inches. owers lilac-purple. May-July. (Zone 4). ources:

Pernettya

:rnettya mucronata
uch-branched evergreen shrub to 1½ ft. ie colorful fruits remain all winter. Many rieties. (Zone 7 to part Zone 6). Sources:

:rnettya mucronata rupicola
lmost prostrate to 6 or 8 inches. (Zone). Sources: ORMN.

ernettya prostrata (nana)
rostrate to 3 or 4 inches. Berries purish-pink. (Zone 7). Sources: 102, ORMN.

ernettya tasmanica
at-forming to 3 or 4 inches. Berries d. (Zone 7). Sources: CAG.

Pieris

ieris (Andromeda) **japonica pygmaea**
ompact evergreen shrub to 3 ft. Leaves rrow. Flowers white, showy. (Zone 5). ources: CAG.

ieris nana (Arcterica nana)
rostrate evergreen shrub to 3 or 4 inches. lowers white. May-June. (Zone 4 to part one 3). Sources:

Polygala

olygala chamaebuxus
vergreen shrublet to 10 inches. Flowers hite with yellow or red keel. April-June. Zone 5). Sources: 102, CAG.

olygala chamaebuxus grandiflora purpurea)
lowers purple or pink with yellow keel. Zone 5). Sources:

olygala vayredae
vergreen shrublet to 3 or 4 inches. Leaves arrow. Flowers rosy-purple. April-May. Zone 6). Sources: 102, CAG.

Cinquefoil

otentilla fruticosa pyrenaica (montana)
USH CINQUEFOIL
ense and partly prostrate to 8 or 10 nches. Flowers yellow. May-August. (Zone). Sources:

Rhododendron, Azalea

hododendron drumonium
vergreen shrub to 1½ ft. Flowers mauve. lay-June. (Zone 6). Sources:

hododendron impeditum
vergreen shrub to 1½ ft. Flowers lavender. lay-June. (Zone 7). Sources: 3, 68, 75, 02, ORMN.

Rhododendron indicum balsaminaeflorum (rosaeflorum)
Procumbent, spreading shrub to 1 ft. Flowers double, salmon. May. (Zone 6). Sources: 102.

Rhododendron williamsianum
Evergreen procumbent shrub to 2½ ft. Flowers rose. July-August. (Zone 5 to Zone 4 (with protection)). Sources: 102.

Other more or less dwarf species and hybrids of Rhododendrons. Sources: 68, 102.

Rose

Rosa chinensis minima
FAIRY ROSE
Half-evergreen much branched shrub to less than 1 ft. Flowers 1 inch across, single or double, pink, white, red or yellow. June-September. Many varieties. (Zone 5). Sources: 24, 75, CAG.

Willow

Salix purpurea nana
DWARF PURPLE OSIER
Deciduous upright shrub to 3 or 4 ft. Leaves grayish-blue. Excellent for low hedges. (Zone 3 to part Zone 2). Sources: 1, 81, 85, 113, IOS, OHH.

Salix uva-ursi
BEARBERRY WILLOW
Prostrate, slow-growing shrub, 2 or 3 inches high. Leaves glossy dark green. (Zone 2 to Zone 1). Sources: 75, 102.

Siphonosmanthus

Siphonosmanthus (Osmanthus) **delavayi**
Slow-growing evergreen shrub to 3 or 4 ft. Leaves glossy dark green. Flowers white, fragrant. April. Berries bluish-black. (Zone 7). Sources: CAG, WBC.

Skimmia

Skimmia reevesiana
Dense evergreen shrub to 1½ ft. Leaves glossy green. Berries crimson, freely produced. (Zone 7 to part Zone 6). Sources: WBC.

Spirea

Spiraea bullata (crispifolia)
Deciduous, compact shrub to 1 ft. Leaves crisped. Flowers deep rose. July-August. (Zone 5). Sources: 63, 75, 102, CAG.

Spiraea bumalda normandi
Dense, deciduous shrub to 1½ ft. Leaves bronze-green, turn purple in fall. Flowers rose-pink. June-July. (Zone 4). Sources: 102.

Germander

Teucrium chamaedrys
SHRUBBY GERMANDER
Bushy evergreen shrublet to 1 ft. Leaves glossy dark green. Useful for edging. Flowers purple or rose. July-September. (Zone 5). Sources: 75, 102, CSN.

Teucrium chamaedrys prostrata
Spreading, forming a dense mat. Sources: 102.

Cranberry

Vaccinium vitis-idaea minus
MOUNTAIN CRANBERRY
Evergreen shrublet to 4 inches, forming dense mats. Leaves glossy dark green. Berries red. (Zone 3). Sources: 14, 61, 75, 102.

Veronica

Veronica, see **Hebe**

Viburnum

Viburnum cassinoides nanum
DWARF WITHE-ROD
Upright deciduous shrub to 1½ or 2 f
Leaves color brightly in fall. Useful f
low hedges. (Zone 3). Sources:

Periwinkle

Vinca minor
SMALL PERIWINKLE
Prostrate evergreen shrublet to 6 inch
Excellent ground cover. (Zone 4).

Vinca minor alba
Flowers white. Sources: 113.

Vinca minor 'Bowles'
Flowers bright blue, freely produce
Sources: 102, 113.

Vinca minor multiplex (alpina, rubra plena)
Flowers double, reddish-purple. Source
OHH.

Early cotoneaster (*Cotoneaster adpressa praecox*) has bright red berries

McFarla

FLOWERING SHRUBS

Broadleaf-Evergreen and Deciduous

Abelia

Abelia grandiflora
GLOSSY ABELIA
Half-evergreen shrub to 5 or 6 ft. Leaves shiny dark green. Flowers white, flushed pink in panicles, June to September. (Zone 6 to part Zone 5). Sources: 47, 113, MDTN.
Selected type: **'Edward Goucher'**
To 3 ft. tall, flowers pink. Sources: 12, 32, 38, 50, 53, 66, MDTN.

Abeliophyllum

Abeliophyllum distichum
KOREAN ABELIA-LEAF
Deciduous shrub to 3½ ft. Leaves spreading in two ranks. Flowers white along the branches before the leaves, April-May or earlier. Looks like a white Forsythia when in bloom. (Zone 5 to part Zone 4). Sources: 4, 62, 63, 113.

Buckeye

Aesculus parviflora
BOTTLEBRUSH BUCKEYE
Spreading shrub to 10 ft. Flowers white in upright, cylindrical panicles. July-August. (Zone 4). Sources: 36, 63, OHH.

Aesculus pavia
RED BUCKEYE
Shrub to 12 or 15 ft. or small tree. Flowers bright red but comparatively small. June. (Zone 6 to part Zone 5). Sources: MDTN.

Juneberry, Service-Berry

Amelanchier asiatica
JAPANESE JUNEBERRY
Tall shrub to 15 ft. or small tree to 25 ft. Leaves whitish underneath. Flowers white in nodding racemes. May. (Zone 5 to part Zone 4). Sources:

Azalea

Azalea, see **Rhododendron**

Barberry

Berberis, see Shrubs for Foliage and Fruits

Butterfly-Bush

Buddleia alternifolia
FOUNTAIN BUTTERFLY-BUSH
Shrub to 10 ft. with wide spreading, arching branches. Flowers fragrant, purplish lilac, in dense clusters along the branches. June. (Zone 5 to large parts of Zone 4). Sources: 1, 7, 14, 63, 109, 114, OHH.

Buddleia davidi
ORANGE-EYE BUTTERFLY-BUSH
Shrub to 10 or 12 ft. Flowers July-October. (Zone 5 to part Zone 4).
Selected hybrid types:
'Charming.' Flowers pink. Sources: 1, 22, 33, 36, 43, 49, 53, 60, 66, 80, 91, 101, OHH.
'Dubonnet.' Flowers dark purple. Sources: 37, 60, 67, 101, 103, OHH.
'Fascinating.' Flowers soft Cattleya-pink. Sources: 67, 113.
'Ile de France.' Flowers lilac-purple. Sources: 33, 43, 71, 91, 101, 112, 114, OHH.
'White Bouquet.' Flowers white. Sources: 7, 36, 71, 103.
Other named varieties: 51, 113.

Heather

Calluna vulgaris
Evergreen shrub of 1½ to 2½ ft. Flowers July to September. Many named varieties with white, pink, purple, crimson and double flowers. (Zone 4). Sources: 12, 31, 43, 47, 61, 75, 113, OHH.

Sweet-Shrub

Calycanthus floridus
CAROLINA ALLSPICE
Deciduous shrub to 6 or 7 ft. Flowers dark reddish-brown, 2 inches across, strongly spicy fragrant. June-July. (Zone 5 to part Zone 4). Sources: 47, MDTN, OHH.

Camellia

Camellia japonica
COMMON CAMELLIA
Evergreen shrub to 25 ft. or more with shiny leaves. Flowers April-June. Many named varieties from white to red and with double flowers. (Zone 7 to part Zone 6). Sources: 5, 12, 32, 38, 42, 45, 50, 63, 66, 105, 112.

Camellia sasanqua
SASANQUA CAMELLIA
Many named varieties. (Zone 6). Sources: 23, 47, 53, 109, MDTN.

Bluebeard

Caryopteris clandonensis 'Blue Mist'
Deciduous shrub to 2 or 2½ ft. Leaves silvery-green. Flowers bright blue in many-flowered cymes. August to October. (Zone 5). Sources: 113, OHH.

Caryopteris clandonensis 'Heavenly Blue'
Flowers dark blue. Sources: 113.

Caryopteris incana (mastacanthus)
Deciduous shrub to 5 ft. Leaves dull green. Flowers violet-blue in dense upright cymes. October-November. (Zone 7 to part Zone 6). Sources: NJPR.

Ceanothus

Ceanothus delilianus
DELISLE CEANOTHUS
Semievergreen shrub to 5 or 6 ft. Flowers pale to deep blue, in many varieties. June or July to August or September. (Zone 7 to part Zone 6). Sources:

Flowering Quince

Chaenomeles (Cydonia) **japonica**
JAPANESE QUINCE
Deciduous shrub to 3 ft. Flowers usually scarlet. April-May or earlier. Many named varieties. (Zone 4 to part Zone 3). Sources: 7, 22, 62, 63, 67, 73, 101, 113, OHH.

Chaenomeles lagenaria
Deciduous shrub to 5 or 6 ft. Flowers March-April. Many named varieties. (Zone 5 to large parts of Zone 4). Sources: 1, 17, 32, 36, 38, 50, 56, 61, 63, 70, 91, 113, 114, MDTN, OHH.

Fringe-Tree

Chionanthus retusus
CHINESE FRINGE-TREE
Deciduous shrub to 12 ft. or small tree. Flowers white in broad panicles. June-July. Fruits dark blue. Sources: 14, 62, 63, OHH.

Chionanthus virginicus
AMERICAN FRINGE-TREE
Deciduous shrub to 20 ft. or tree to 25 ft. Flowers white in loose panicles. May-June. Fruits dark blue. (Zone 4). Sources: 47, MDTN, OHH.

Mexican-Orange

Choisya ternata
Evergreen shrub to 7 or 8 ft. Leaves aro matic. Flowers white, over 1 inch across fragrant. May-June. (Zone 7 to part Zon 6). Sources: 12, WBC.

Clematis

Clematis, Vines, rather than shrubs Sources: 40, many species and varieties

Glory-Bower

Clerodendrum trichotomum
Upright shrub to 10 or 15 ft. North o Zone 6 usually only to 4 or 5 ft. Even when killed to the ground flowers on the young shoots. Flowers white, fragrant, bract crimson, fruits blue. August to Septembe or October. (Zone 6 to large parts of Zon 5). Sources: 14 ?

White-Alder

Clethra alnifolia
SWEET PEPPERBUSH
Deciduous shrub to 7 or 8 ft. Flowers whit fragrant, in upright, panicled raceme July-September. (Zone 4 to part Zone 3) Sources: 47, MDTN, OHH.

Clethra alnifolia rosea
PINK PEPPERBUSH
Flowers pale pink. (Zone 4). Source 14, 18, 37, 47, 60, 61, 63, 66, 81, 86, 11 Selected type: **'Pink Spire.'** Source MDTN.

Clethra barbinervis
JAPANESE PEPPERBUSH
Deciduous shrub to 15 ft. or small tre Flowers white, fragrant. The upright racemes somewhat longer. (Zone 5 to pa Zone 4). Sources: 14, 62, 63, MDTN, OHH

Cornelian Cherry

Cornus mas
CORNELIAN CHERRY
Deciduous shrub to 15 ft. or small tre Leaves remain green late in fall. Flowe bright yellow, in great profusion along th branches. March-April. (Zone 4 to pa Zone 3). Sources: MDTN, OHH.

Cornus mas elegantissima
VARIEGATED CORNELIAN CHERRY
Shrub to 10 ft. or more. Leaves variegat creamy white and flushed red. (Zone 4 Sources: 35, 43, 60, 64.

Cornus officinalis
JAPANESE CORNELIAN CHERRY
Shrub to 15 ft. or small tree to 25 f Similar to *C. mas*. Flowers yellow. Marc April or earlier. (Zone 5 to part Zone 4 Sources: 47, 113, OHH.

For other Cornus, see Shrubs for Folia and Fruit

Winter Hazel

orylopsis glabrescens
eciduous shrub to 12 ft. or more. Leaves uish underneath. Flowers pale yellow, in ort pendulous racemes, before the leaves. arch or April. (Zone 5 to part Zone 4). ources: 63.

orylopsis pauciflora
preading shrub to 4 or 5 ft. Flowers prim-se yellow, in short, more or less upright ikes. March-April. (Zone 6 to part Zone). Sources: 102.

orylopsis sinensis
hrub to 10 ft. or more. Flowers pale yel-w in pendulous racemes. March-April. Zone 6 to part Zone 5). Sources: MDTN, HH.

orylopsis spicata
hrub to 4 or 5 ft. One of the prettiest of ne hardier species. Flowers bright yellow ith purple anthers, fragrant. March-April. Zone 5 to part Zone 4). Sources: 47.

Cotoneaster

otoneaster multiflora and var. **calocarpa**
eciduous shrub to 8 ft. Outstanding in his genus for its abundant, showy white owers. May. Fruits red. (Zone 4). Sources: 6, 113, 114, OHH.

or other Cotoneasters, see Shrubs for oliage and Fruits

Leatherwood

yrilla racemiflora
emievergreen shrub to 15 ft. or more or mall tree. Leaves turn orange and scarlet n fall. Flowers white in slender, pendulous acemes. June-July. Sources: MDTN.

Broom

ytisus albus
ORTUGUESE BROOM
preading shrub to 1½ ft. Flowers white or ream in terminal heads. June-July or Au-ust. (Zone 5). Sources: 47.

ytisus battandieri
hrub to 3 ft. With silvery gray leaves. lowers fragrant, golden-yellow in cylin-rical heads. July-August. (Zone 6). ources: MDTN.

ytisus nigricans
PIKE BROOM
pright shrub to 4 or 5 ft. Flowers yellow n terminal to 1 ft. long racemes. June-uly. (Zone 5 to part Zone 4). Sources: 14.

ytisus nigricans elongatus
Blooms again in fall. (Zone 5). Sources:

ytisus praecox
ARMINSTER BROOM
hrub to 4 or 5 ft. with arching branches. lowers sulfur-yellow produced all along he branches. May-June. (Zone 5). Sources: 12, 14, 18, 31, 62, 113.

Cytisus scoparius
SCOTCH BROOM
Upright shrub to 6 ft. Flowers bright yellow, comparatively large, in great profusion. May-June. (Zone 5 to part Zone 4). Sources: 2, 18, 31, 32, 38, 47, 61, 62, 81, 112, OHH.

Cytisus scoparius andreanus
Flowers yellow with crimson wings. (Zone 5). Sources: OHH.

Cytisus versicolor (purpureus x hirsutus)
Upright shrub with arching branches to 3 ft. Flowers with white standards marked purple and with pale yellow wings. May-June. (Zone 5). Sources: 102.

For other Brooms, see Dwarf Shrubs

Irish-Heath

Daboecia cantabrica (polifolia)
Upright, evergreen shrub to 1½ ft. Flowers bell-shaped, nodding on upright racemes, pink or white. July-September. (Zone 6). Sources: 75, 102.

Daphne

Daphne burkwoodi (Somerset) (caucasia x cneorum)
Semievergreen shrub to 3 or 4 ft. Dark green. Flowers white, flushed pink, fragrant. May-June. (Zone 4 to part Zone 3). Sources: 14, 113.

Daphne genkwa
LILAC DAPHNE
Upright, deciduous shrub to 3 ft. Flowers lilac but scentless, all along the branches. April-May. (Zone 6 to part Zone 5). Sources: 113, MDTN.

Daphne houtteana (laureola x mezereum)
Upright semievergreen shrub to 3 ft. Flowers lilac-violet in short-stalked clusters. April-May. (Zone 6 to part Zone 5). Sources:

Daphne mezereum
MEZEREUM
Upright, deciduous shrub to 3 ft. Fruits scarlet but poisonous. Flowers lilac-purple or white, in clusters along the upright branches. March-April or earlier. (Zone 4 to part Zone 3). Sources: 14, 67, 81, 102, OHH.

For other Daphnes, see Dwarf Plants

Deutzia

Deutzia elegantissima
Upright, deciduous shrub to 5 ft. Flowers ¾ inch across, tinted rose outside and inside, fragrant. May-June. (Zone 5). Sources: 113.

Deutzia gracilis
Slender branched shrub to 3 or 4 ft. Flowers white in upright panicles or racemes. May-June. (Zone 5 to part Zone 4). Sources: 47, 113.

Deutzia kalmiaeflora
Shrub to 3 or 4 ft. with arching branches. Flowers cup-shaped. White inside, carmine outside. May-June. (Zone 5). Sources: 113.

Deutzia lemoinei
Shrub to 5 ft. Flowers white in pyramidal panicles, freely produced. May-June. (Zone 4). Sources: 47, OHH.

Deutzia lemoinei compacta 'Boule de Neige'
More compact in growth, to 3 or 4 ft. (Zone 4). Sources: 94, OHH.

Deutzia rosea
Shrub to 4 or 5 ft. Flowers open bell-shaped, pink outside. May-June. (Zone 5 to part Zone 4). Sources: 28, 36, 37, 53, 60, 62, 91, 101, 114, OHH.

Deutzia rosea campanulata
Flowers white, 1 inch across. (Zone 5). Sources:

Deutzia rosea eximia
Flowers purplish-pink. (Zone 5). Sources: IOS.

Deutzia scabra plena 'Pride of Rochester'
Tall erect shrub. Flowers double-white, flushed rose outside. June-July. (Zone 4). Sources: OHH.

Deutzia scabra pendula
Shrub to 4 ft. with arching branches. (Zone 5 to 4) Flowers white, single, abundantly produced. (Zone 5 to 4). Sources: 113.

Deutzia vilmorinae
Graceful shrub to 5 ft. Flowers white, single, 1 inch across in loose corymbs. June. (Zone 5). Sources:

Elsholtzia

Elsholtzia stauntoni
Shrub to 3 or 4 ft. Flowers lilac in dense, one-sided spikes. September-October. (Zone 4). Sources: 113, OHH.

Enkianthus

Enkianthus campanulatus
Necklace Bush, Redvein Enkianthus
Upright shrub to 15 ft. South of Zone 4 sometimes tree-like to 20 ft. or more. Leaves turn brilliant red in fall. Flowers bell-shaped, in drooping racemes, yellowish with red veining. May. (Zone 4). Sources: 47, 57, MDTN.

Enkianthus perulatus
White Enkianthus
Shrub to 5 or 6 ft. Leaves turn orange and scarlet in fall. Flowers smaller, but white and showy, before the leaves. March-April. (Zone 5). Sources:

Heath

Erica carnea
Spring Heath
Evergreen shrub to 1 ft. or less. Flowers pink, red or white. March-April. (Zone 5 to part Zone 4). Sources for named varieties: 12, 18, 61, 62, 113.

Erica cinerea
Twisted Heath
Evergreen shrub to 1½ or 2 ft. Flowers pink, red, rose, purple or white. June-August. (Zone 5). Sources for named varieties: 75.

Erica darleyensis
Darley Heath
Shrub to 2 ft. or more. Flowers rose-pink October-March. (Zone 6 to part Zone 5) Sources: 31, 57, 62, 75, 86.

Erica tetralix
Cross-Leafed Heath
Evergreen shrub to 1½ or 2 ft. Grayish green. Flowers rose-pink or white. June August or September. (Zone 4 to part Zone 3). Sources for named varieties: 75.

Erica vagans
Cornish Heath
Spreading, evergreen shrub to 1½ ft., dark green. Flowers pink, red or white. August to October. (Zone 6 to part Zone 5) Sources for named varieties: 50, 57, 75 84, OHH.

Erica williamsi (tetralix x vagans)
Evergreen shrub to 1½ ft. Flowers rose pink, July-September. Sources:

Pearl-Bush

Exochorda giraldi wilsoni
Upright deciduous shrub to 6 or 8 ft. Flowers white, 2 inch across. April-May. (Zone 5). Sources: OHH.

Exochorda macrantha 'The Bride'
Upright shrub to 4 or 5 ft. Flowers white to 2 inch across. April-May. (Zone 5 to part Zone 4). Sources: 113.

Exochorda racemosa (grandiflora)
Somewhat hardier than the other two but less handsome. Flowers smaller. (Zone 4) Sources: 2, 47, 53, 61, 112, 114, OHH.

Forsythia, Golden-Bells

Forsythia intermedia
Upright deciduous shrub with spreading branches. 5 to 7 ft. Flowers various shades of yellow. April-May or earlier. (Zone 4) Named types:
'Beatrix Farrand.' Sources: 7, 10, 60, 7 91, 114.
'Lynwood Gold.' Sources: 113.
'Spring Glory.' Sources: 47, 113.

Forsythia ovata
KOREAN FORSYTHIA
Deciduous shrub to 4 ft. or more with spreading branches. Flowers pale yellow. April-May or earlier. (Zone 4 to part Zone 3). Sources: 1, 47, 70, 76, 114, IOS, OHH.

Forsythia suspensa
WEEPING FORSYTHIA
Deciduous shrub to 6 or 7 ft. with long, slender, arching branches. Flowers golden yellow. April-May. (Zone 5 to part Zone 4). Sources: 28, 47, 54, 63, 76, 85, 91, 96, 101, 112, 114, OHH.

Forsythia suspensa atrocaulis
With purplish young growth and dark purple branches. (Zone 5). Sources:

Forsythia suspensa fortunei
Vigorous and upright shrub with spreading branches. (Zone 5). Sources: 1, 12, 22, 49, 54, 76, 101, 114.

Forsythia suspensa sieboldi
Shrub with very slender, trailing branches. (Zone 4). Sources: OHH.

Fothergilla

Fothergilla major
Upright deciduous shrub to 6 or 7 ft. Leaves turn orange-yellow in fall. Flowers white in upright, 2-inch long spikes. May. (Zone 5 to part Zone 4). Sources: 14, 63, 114.

Fothergilla monticola
Spreading deciduous shrub to 5 ft. Leaves turn orange-yellow in fall. Flowers white in upright, 2½-inch long spikes. May. (Zone 5 to part Zone 4). Sources: 14.

Franklinia

Franklinia (Gordonia) alatamaha
Shrub to 10 ft. South of Zone 5 sometimes tree to 25 ft. Leaves turn crimson in fall. Flowers cup-shaped, white, 3 inches across. September-October. (Zone 5 to part Zone 4). Sources: 18, 20, 38, 47, 54, 63, 91, 109, 112, 114.

Fuchsia

Fuchsia magellanica
HARDY FUCHSIA
Shrub to 2 or 3 ft. with slender, arching branches. Flowers reddish-purple. June to September. (Zone 6 or Zone 5 with protection). Sources: 113.

Broom

Genista radiata
Densely branched and compact, deciduous shrub to 2½ ft. Grayish-green. Flowers in heads, bright yellow. May to July. (Zone 5). Sources: 102.

Genista tinctoria plena
DOUBLE-FLOWERED DYER'S GREENWEED
Upright shrub to 2½ or 3 ft. Flowers double, golden-yellow in many-flowered racemes. June to August. (Zone 5 to part Zone 4). Sources:

For other Genistas, see Dwarf Shrubs

Witch-Hazel

Hamamelis japonica
JAPANESE WITCH-HAZEL
Shrub to 10 ft. or small tree to 20 ft. Leaves turn orange in fall. Flowers with bright yellow petals and purple sepals. January to March. (Zone 5 to part Zone 4). Sources: MDTN, OHH.

Hamamelis mollis
CHINESE WITCH-HAZEL
Shrub to 12 ft. or small tree to 25 ft. Leaves turn bright yellow in fall. Flowers golden-yellow, reddish at base, comparatively large. January to March. (Zone 5 to part Zone 4). Sources: 2, 14, 47, 62, 63, 109, 114, MDTN, OHH.

Hamamelis virginiana
COMMON OR AMERICAN WITCH-HAZEL
Shrub to 8 or 10 ft. The hardiest of the Witch-Hazels. Leaves turn bright yellow in fall. Flowers with bright yellow petals and brownish sepals. September-October. (Zone 4 to part Zone 3). Sources: 47, MDTN, OHH.

Hamamelis vernalis
SPRING WITCH-HAZEL
Upright shrub to 5 or 6 ft. The least handsome of the Witch-Hazels. Flowers light yellow or reddish, rather small. December to March. (Zone 5). Sources: 1, 28, 47, 61, 63, 91, 114, OHH.

Rose-Mallow

Hibiscus syriacus
SHRUB-ALTHAEA, ROSE-OF-SHARON
Deciduous shrub to 10 ft. or more or small tree. Flowers single or double, white, rose-pink, red, purplish or bluish. August to September. Many named varieties. (Zone 5). Sources: 47, 113, OHH.

Hydrangea

Hydrangea arborescens grandiflora
HILLS-OF-SNOW
Shrub to 3 or 5 ft. forming a round bush. Flowers white, all sterile, in large, globose heads. June-July. (Zone 4). Sources: 54, 60, 62, 112.

Hydrangea cinerea sterilis
Spreading shrub to 4 or 5 ft. Leaves grayish, hairy underneath. Flowers white, all sterile in roundish heads. June-July. (Zone 5). Sources: OHH.

Hydrangea macrophylla (opuloides) (hortensis)
HORTENSIA, FOUR-SEASON
Deciduous shrub to 8 ft. or more. North of Zone 6 usually only 3 to 4 ft. Flowers all sterile in half-round heads. White, pink or blue. June-July. (Zone 6 to part Zone 5). Many named varieties. Sources: 18, 42, 50, 56, 60, 67, 81, 112, 113, OHH.

Hydrangea macrophylla 'Domotoi' (hardy strain)
Shrub to 3 ft. with pink or blue flowers (depending on soil pH). (Zone 4). Sources: 113.

Hydrangea paniculata grandiflora
PEEGEE HYDRANGEA
Shrub to 15 ft. or more. Flowers sterile, white in pyramidal panicles. July-August to September. (Zone 4 to part Zone 3). Sources: 47, 62, 112, 113, OHH.

Hydrangea paniculata praecox
Flowers only partly sterile, white. June-July to August. Sources: 47, OHH.

Hydrangea quercifolia
OAKLEAF HYDRANGEA
Shrub to 5 ft. with large lobed leaves. Flowers in large panicles. Sterile flowers numerous, white. June. (Zone 6 to part Zone 5). Sources: 2, 32, 36, 48, 56, 81, 97, 113, OHH.

Hydrangea xanthoneura
CHINESE HYDRANGEA
Shrub to 12 ft. with rather large, dark green leaves. Flowers in loose corymbs. Sterile flowers white. July. (Zone 5 to part Zone 4). Sources:

St. Johnswort

Hypericum arnoldianum (lobocarpum x galioides)
Upright shrub to 3 ft. Very floriferous. Flowers about ½ inch across, golden yellow in cylindrical panicles. July to September. (Zone 5 to part Zone 4). Sources:

Hypericum calycinum
Evergreen or semievergreen shrub to 1 ft. with dark green leaves, bluish beneath. Flowers 3 inches across, bright yellow. July-September. (Zone 5 to part Zone 4). Sources: 53, 63, 66, 113.

Hypericum frondosum (aureum)
Upright, deciduous, dense shrub to 3 ft. with stout branches. Flowers 1-2 inches across, bright yellow. July-August. (Zone 4). Sources: 71, 102, OHH.

Hypericum kalmianum
Deciduous shrub to 2½ ft. with bluish green leaves. Flowers 1 inch across, bright yellow. July-August. (Zone 4). Sources: 14, 62, 94, OHH.

Hypericum moserianum (patulum x ealycinum)
Semievergreen shrub to 3 ft. with reddis stems. Flowers 2-2½ inches across, golde yellow. July-September. (Zone 6 to par Zone 5). Sources: 53, OHH.
Selected type: **'Hidcote'** about 2 ft. higl (Zone 5). Sources 91, 113.

Hypericum patulum henryi
Half-evergreen, spreading shrub to 2½ f Free flowering. Flowers 2 inches across golden yellow. July-September. (Zone to part Zone 5). Sources: 56, OHH.
Selected type: **'Sungold.'** Flowers 2½ inc across. (Zone 5). Sources: 113.

Hypericum prolificum
Upright, deciduous shrub to 4 ft. with shiny dark green leaves. Flowers 1 inch across bright yellow in cymes. July-Septembe (Zone 4). Sources: 18, OHH.

Hypericum vanfleeti (prolificum x frondosum)
Deciduous shrub to 3 ft. Flowers 1½ inc across, bright yellow, freely produced. July September. (Zone 4). Sources: OHH.

Indigo

Indigofera kirilowi
Deciduous shrub to 3 ft. or more with slender upright branches. Flowers rose-crimso in dense racemes. June-July. (Zone 4 Sources: OHH.

Indigofera potanini
Upright, deciduous shrub to 4 ft. Flowe lilac-pink in racemes. June-July. (Zone to part Zone 4). Sources:

Virginia-Willow, Sweet Spire

Itea virginica
Upright shrub to 3 or 4 ft. Leaves tur brilliant red in fall. Flowers white, fr grant in upright racemes. June-July. (Zo 5). Sources: OHH.

Jasmine

Jasminum nudiflorum
WINTER JASMINE
Deciduous shrub with slender archin branches. Flowers bright yellow, 1 inc across. March-April or earlier. (Zone 5 Sources: MDTN, OHH.

Jasminum stephanense (beesianum x officinale)
Slender shrub to 3 or 4 ft. with archin branches. Flowers light pink, fragran about ½ inch across. May-June. (Zone to part Zone 6). Sources: MDTN.

Mountain-Laurel

Kalmia latifolia
Evergreen shrub to 15 or 25 ft. With dar green leaves. Flowers rose-pink, sauce shaped in large corymbs. May-June. (Zo 4). Sources: 29, 57, MDTN, OHH, PAF

Kerria

Kerria japonica
Deciduous shrub to 4 ft. with green-striped branches. Flowers bright yellow. May. (Zone 4). Sources: 67, 112, OHH.

Kerria japonica aureo-variegata
Leaves edged yellow. Sources: 14.

Kerria japonica pleniflora
Flowers double. Sources: 7, 38, 49, 54, 60, 61, 67, 101, 113, PAFA.

Beauty-Bush

Kolkwitzia amabilis
BEAUTY-BUSH
Graceful deciduous shrub to 6 ft. Flowers pink in great profusion. May-June. (Zone 4). Sources: 47, 113, OHH, PAFA.

Crape-Myrtle

Lagerstroemia indica
Deciduous shrub to 10 ft. or more or small tree. Flowers pink, red, purple or white. July to September. (Zone 6). Selected types. Sources: 32, 38, 42, 45, 46, 53, 66, 80, IOS, MDTN.

Leptodermis

Leptodermis oblonga
Deciduous shrub to 2½ or 3 ft. with small leaves. Flowers violet-purple in clusters. July to September or October. (Zone 6 to part Zone 5). Sources:

Bush Clover

Lespedeza bicolor
Deciduous upright shrub to 6 ft. or more with slender, arching branches. Flowers rosy-purple in large, loose panicles. August-September. (Zone 4). Sources: OHH.

Lespedeza thunbergi (desmodium penduliflorum)
Deciduous shrub to 4 or 5 ft. with slender arching branches. Flowers rosy-purple in large terminal panicles. September-October. (Zone 5). Sources:

Honeysuckle

Lonicera amoena arnoldiana (tatarica x korolkowi)
Deciduous shrub to 8 ft. with small bluish-green leaves. Berries red. Flowers white flushed pink in great profusion. May-June. Handsomer than either parent. (Zone 4 to part Zone 3). Sources: 70, OHH.

Lonicera fragrantissima
Semievergreen shrub with spreading arching branches. Flowers white, fragrant. March-April. (Zone 6 to part Zone 5). Sources: 47, 54, 66, MDTN, OHH.

Lonicera gracilipes
Upright deciduous shrub to 4 or 5 ft. with reddish young branches. Flowers pink or white, nodding, appearing with the leaves. Berries red. April-May. (Zone 4). Sources: OHH.

Lonicera morrowi
Deciduous shrub to 4 or 5 ft. with wide-spreading branches. Flowers yellow in great profusion. May-June. Berries dark red. (Zone 3). Sources: 47, 54, 66, OHH.

Lonicera pyrenaica
Upright, deciduous shrub to 3 ft. Leaves bluish-green. Flowers white or flushed pink, nodding, 1½ inch long. May. Berries red. (Zone 5). Sources:

Lonicera spinosa alberti
Low deciduous shrub with arching or prostrate branches. Leaves bluish-green. Flowers rosy-pink. June. (Zone 4 to part Zone 3). Sources:

Lonicera standishi
Semievergreen, upright shrub to 4 or 5 ft. Leaves dark green above. Flowers white, fragrant. March-April. (Zone 5). Sources: OHH.

Lonicera syringantha
Upright shrub to 5 ft. or more with slender branches. Leaves bluish-green. Flowers soft pink to rosy-lilac, fragrant, freely produced. May-June. (Zone 4). Sources: OHH.

Lonicera tatarica
TATARIAN HONEYSUCKLE
Shrub to 8 ft. or more. Berries red. Flowers pink or white. Freely produced when the shrub is not trimmed. May-June. (Zone 3). Many varieties. Sources: 47, 60, 66, 80, OHH.

Lyonia

Lyonia mariana
STAGGER-BUSH
Deciduous shrub to 4 ft. or more. Flowers white or pinkish in nodding clusters. Freely produced. May-June. (Zone 5). Sources:

Magnolia

Magnolia kobus nana compacta
Densely bushy to 8 or 10 ft. Flowers white. April-May. (Zone 5 to part Zone 4). Sources:

Magnolia liliflora nigra
LILY-FLOWERED MAGNOLIA
Shrub to 8 ft. or more. Flowers dark purple outside, light purple inside, almost 5 inches long. May-June. (Zone 6 to part Zone 5). Sources: 48.

Magnolia stellata
STAR MAGNOLIA
Shrub to 10 ft. or more or small tree. Flowers white, star-shaped. March-April. (Zone 5 to part Zone 4). Sources: 6, 14, 36, 47, 53, 62, 66, 81, 86, 91, 109, 114, OHH.

Magnolia stellata rosea
PINK STAR MAGNOLIA
Flowers flushed pink outside. (Zone 5). Sources: 28, 63, 114, MDTN, OHH.

Magnolia stellata 'Dr. Merrill'
Faster-growing and hardier. Flowers white, star-shaped. April. (Zone 4). Sources: 113.

Magnolia virginiana
SWEET BAY
Semievergreen shrub to 8 ft. or more. Tree to 15 ft. or more in the South. Leaves shiny bluish-green. Flowers white, fragrant, almost 3 inches across. June-July. (Zone 5). Sources: 109, OHH.

Magnolia wilsoni
WILSON'S MAGNOLIA
Shrub to 10 ft. or small tree. Leaves whitish beneath. Flowers white, cup-shaped 5 inches across, fragrant. June. (Zone 6). Sources: 14, 34.

Mahonia

Mahonia, see Shrubs for Foliage and Fruits

Flowering Crab-Apple

Malus sargenti
SARGENT'S CRAB-APPLE
Spreading shrub to 4 or 5 ft. with stiff, spiny branches. Fruits small dark red. Flowers white, 1 inch across, freely produced. May. Leaves turn orange and scarlet. (Zone 4). Sources: 28, 36, 47, 70, 71, 81, 91, 109, 114, OHH.

Neillia

Neillia longiracemosa
Deciduous shrub to 4 or 5 ft. Flowers pink in dense racemes. May-June. (Zone 6 to part Zone 5). Sources: OHH.

Neillia sinensis
Graceful, deciduous shrub to 5 ft. with slender, spreading branches. Flowers pale pink, nodding on numerous panicles. May-June. (Zone 5). Sources:

Tree Peony

Paeonia suffruticosa
Shrub to 4 or 5 ft. with stout branches. Flowers large, single or double, white, rose or red. May-June. Many named varieties. (Zone 5 and Zone 4 (with protection)). Sources: 14, 93, 98, 109.

Perovskia

Perovskia atriplicifolia
Upright shrub to 3 or 4 ft. Flowers blue in whorls on slender spikes. August-September. (Zone 5 to part Zone 4). Sources:

Mock-Orange

Philadelphus coronarius
MOCK-ORANGE
Shrub to 6 or 7 ft. Flowers creamy-white very fragrant, 1 to 1½ inch across. June (Zone 4). Sources: 62, 66.

Philadelphus coronarius plenus
Flowers double. Sources: OHH.

Philadelphus cymosus
Shrub to 8 ft. June. (Zone 4).
Selected types:
'Atlas.' Very large single flowers. Sources 113, 114, OHH.
'Banniere.' Semidouble flowers. Sources OHH.
'Norma.' Single or double flowers. Sources OHH.

Philadelphus lemoinei
Shrub to 4 or 5 ft. with rather small leaves. Flowers creamy-white, very fragrant. June (Zone 5 to part Zone 4).
'Avalanche.' Sources: 70, OHH.
'Mont Blanc.' Sources: 101.

Philadelphus polyanthus
Shrub to 6 or 8 ft. Flowers creamy-white 1½ inch across. June-July. (Zone 4).
'Favorite.' Sources: OHH.
'Gerbe de Niege.' Sources:

Philadelphus purpureo-maculatus
Shrub to 5 or 6 ft. Flowers white with purple spots or flush at the base. June (Zone 6 to part Zone 5).
'Beauclerc.' Sources: 113.
'Belle Etoile.' Sources: 12, 113, IOS.
'Etoile Rose.' Sources: OHH.
'Sybille.' Sources: 113.

Philadelphus virginalis
Shrub to 5 or 6 ft. Flowers white, double or semidouble. June. (Zone 4).
'Albatre.' Sources: OHH.
'Argentine.' Sources: OHH.
'Bouquet Blanc.' Sources: OHH.
'Enchantment.' Sources: 113.
'Frosty Morn.' Sources: 60.
'Minnesota Snowflake.' Sources: 12, 35, 36, 48, 60, 66.
'Virginal.' Sources: OHH, PAFA.

Pieris

Pieris (Andromeda) **floribunda**
MOUNTAIN ANDROMEDA
Evergreen shrub to 4 or 5 ft. Flowers nodding, white, in dense panicles. April-May (Zone 4). Sources: 29, OHH.

Pieris japonica
JAPANESE ANDROMEDA
Evergreen shrub to 6 or 7 ft. with spreading branches. Leaves shiny green. Flowers white in pendulous panicles. April-May (Zone 6 to part Zone 5). Sources: 57, MDTN, OHH.

eris japonica variegata
) 4 ft. Leaves with whitish margins. Zone 6). Sources: 63, 109, MDTN.

eris taiwanensis
ORMOSA ANDROMEDA
Evergreen shrub to 4 or 5 ft. Flowers nite in upright panicles with drooping anches. April-May. (Zone 7 to part Zone . Sources: 63.

Cinquefoil

otentilla fruticosa 'Katherine Dykes'
USH CINQUEFOIL
eciduous shrub to 3½ ft. Flowers lemon-llow. June-September. (Zone 4). Sources: 3, CSN, MDTN.

otentilla fruticosa parvifolia 'Gold Drop'
ense shrub with small leaves, to 3½ ft. lowers bright yellow. June-September. Zone 4). Sources: 62, 113, OHH.

otentilla fruticosa veitchi
rub to 4 ft. with pure white flowers. ne-July. (Zone 5). Sources: 63, 75, 102, 4.

otentilla fruticosa vilmoriniana
rub to 5 ft. Grayish leaves, cream flow-s. June-July. (Zone 5). Sources: 102, SN.

Flowering Almond, Apricot, Cherry

runus glandulosa
WARF FLOWERING ALMOND
eciduous shrub to 4 or 5 ft. Flowers pink white, single. April-May. (Zone 4). ources: 1, 2, 7, 22, 32, 37, 49, 53, 54, 61, 6, IOS, OHH, PAFA.

runus glandulosa albi-plena
HITE DOUBLE-FLOWERING ALMOND
lowers double, white. (Zone 5). Sources: , 66, 85, OHH.

runus glandulosa sinensis (rosea-plena)
INK DOUBLE-FLOWERING ALMOND
lowers double, pink. (Zone 5). Sources: , 112, 113, 114, OHH.

runus incisa
UJI CHERRY
eciduous shrub to 12 ft. or small tree. lowers white, flushed pink. April-May. Zone 5 to part Zone 4). Sources:

runus japonica
HINESE BUSH CHERRY
eciduous shrub to 4 or 5 ft. Fruits globose, ed. Flowers pale pink, freely produced. pril-May. (Zone 3). Sources: OHH.

runus mume flore pleno
APANESE APRICOT
hrub to 10 ft. or small tree. Flowers ouble, pink. March-April. (Zone 6). ources:

runus tenella (Amygdalus nana)
WARF RUSSIAN ALMOND
hrub to 3 or 4 ft. Flowers white or red, ingle. April-May. (Zone 3). Sources:

Prunus tomentosa
MANCHU CHERRY, NANKING CHERRY
Deciduous shrub to 6 or 7 ft. Fruits scarlet, edible. Flowers white, flushed pinkish, freely produced. March-April. (Zone 3). Sources: 1, 12, 47, 59, 60, 61, 70, 76, 80, 85, 114, OHH.

Prunus triloba multiplex
FLOWERING ALMOND
Deciduous shrub to 5 or 6 ft. or more. Flowers fully double, pink, 1 inch across. April-May. (Zone 4 to part Zone 3). Sources: 113.

Pomegranate

Punica granatum
Deciduous shrub to 8 or 10 ft. or small tree. Flowers scarlet, 1½ inch across. May-June. (Zone 7). Sources: 38, 66.

Rhododendron, Azalea

Rhododendron arborescens
SWEET AZALEA
Deciduous shrub to 6 ft. or more. Flowers white, rather large, sweetly fragrant. June-July. (Zone 4). Sources: 39, 47, 85.

Rhododendron atlanticum
Deciduous, spreading, suckering shrub to 2½ ft. Flowers white, flushed pink, very fragrant. April-May. (Zone 6). Sources: 47, MDTN.

Rhododendron calendulaceum
FLAME AZALEA
Deciduous shrub to 6 or 8 ft. Flowers yellow to orange or scarlet. May-June. (Zone 5 to part Zone 4). Sources: 22, 47, 53, 85, 109, 112, 114.

Rhododendron canadense (Rhodora canadensis)
RHODORA
Deciduous shrub to 2½ ft. Leaves bluish-green. Flowers rose-pink or white. April-May. (Zone 3 to part Zone 2). Sources: 47, MDTN, OHH.

Rhododendron carolinianum
CAROLINA RHODODENDRON
Evergreen shrub to 4 or 5 ft. Flowers 1½ inches across, light rosy purple. May-June. (Zone 5 to part Zone 4). Sources: 43, 65, 109, 114.
Varieties of *R. carolinianum*. Sources: 22, 28, 81, 114.

Rhododendron catawbiense
CATAWBA RHODODENDRON, MOUNTAIN ROSE BAY
Evergreen shrub to 5 ft. or more. Flowers 2½ inches across, lilac-purple. May-June. Sources: 22, 43, 47, 81, 85, 109, 112, 114, PAFA.
Hybrids of *R. catawbiense* in red, mauve and pink. Sources: 22, 39, 43, 47, MDTN.

Rhododendron dauricum
DAHURIAN RHODODENDRON
Shrub to 4 or 5 ft. Leaves deciduous or partly persistent. Flowers rosy-purple. March-April. (Zone 4 to part Zone 3). Sources:

Rhododendron fortunei
Evergreen shrub to 8 ft. or more. Flowers rosy-lilac or blue-pink. May-June. (Zone 6). Sources: 39, MDTN.

Rhododendron japonicum
JAPANESE AZALEA
Deciduous shrub to 4 or 5 ft. Flowers 2 inches across, orange, salmon, red or yellow. April-May. (Zone 5). Sources:

Rhododendron keiskei
Evergreen shrub to 4 or 5 ft. or procumbent. Flowers pale yellow. May. (Zone 6 to part Zone 5). Sources: 39, 47.

Rhododendron laetevirens (carolinianum x ferrugineum)
Spreading, evergreen shrub to 3 ft. Flowers over 1 inch across, rose. June. (Zone 5 to part Zone 4). Sources: 22, 113.

Rhododendron luteum
YELLOW AZALEA
Deciduous shrub to 8 ft. or more. Flowers yellow, very fragrant. May. (Zone 6 to part Zone 5). Sources: OHH.

Rhododendron maximum
ROSE BAY
Evergreen shrub to 15 ft. or more or small tree. Flowers rose-purple, spotted orange. June-July. (Zone 4 to part Zone 3). Sources: 22, 39, 53, 65, 85, 109, 112, 114, OHH.

Rhododendron molle
CHINESE AZALEA
Deciduous shrub to 3 or 4 ft. Flowers golden-yellow, spotted greenish. April-May. (Zone 5). Sources: 47, OHH.

Rhododendron mucronatum
SNOW AZALEA
Evergreen or semievergreen shrub to 5 ft. or more. Flowers white or pink. May. (Zone 6 to part Zone 5). Sources: 113, 114.

Rhododendron mucronulatum
KOREAN RHODODENDRON
Deciduous shrub to 4 or 5 ft. Flowers light rosy-purple, before the leaves. March-April. (Zone 4 to part Zone 3). Sources: 22, OHH.

Rhododendron nudiflorum
PINXTER-FLOWER AZALEA
Deciduous shrub to 4 or 5 ft. Flowers light pink or white. April-May. (Zone 4 to part Zone 3). Sources: 47, OHH.

Rhododendron obtusum kaempferi
Semievergreen shrub to 6 or 7 ft. Leaves turn orange and scarlet in fall. Flowers red or pink, before or with the leave April-May. (Zone 5 to part Zone 4 Sources: 2, 22, 105, 109, 114.

Rhododendron ponticum
Evergreen shrub to 5 or 6 ft. Flowers lila purple, spotted brownish. May-June. (Zo 7 to part Zone 6). Sources:

Rhododendron racemosum
Shrub to 4 or 5 ft. Leaves semi-persisten Flowers pink. April-May. (Zone 6 to pa Zone 5). Sources: 39, 102, 109.

Rhododendron roseum
Deciduous shrub to 6 ft. or more. Leav bluish-green. Flowers bright pink or whitis fragrant. May. (Zone 4 to part Zone 3 Sources: 47 (varieties).

Rhododendron schlippenbachi
ROYAL AZALEA
Deciduous shrub to 10 ft. or more. Leav turn orange and crimson in fall. Flowe rosy-pink, fragrant. May. (Zone 4). Source 2, 22, 39, 43, 47, 113, 114, MDTN, OHH.

Rhododendron vaseyi
Deciduous shrub to 8 or 10 ft. Flowe light rose-pink, spotted orange, before t leaves. April-May. (Zone 4). Source MDTN, OHH.

Rhododendron yedoense poukhanense
Deciduous or semievergreen, compact shr to 3 or 4 ft. Flowers pale-lilac, spott purple, fragrant. May. (Zone 4). Source 22, 39, 53, 109, 114, MDTN, OHH.

Azalea Hybrids

Rhododendron gandavense
GHENT AZALEA
Complex hybrids involving the specie calendulaceum, luteum, molle and nudifl rum. Deciduous shrubs to 4 ft. Flowers many colors, also hose-in-hose. April-Ma (Zone 4). Sources: 22, 43, 105, 114, MDT OHH.

Rhododendron molle hybrids with cale dulaceum, occidentale and japonicum Supreme hybrid Azaleas. (Zone 5). Source 113. Also: 20, 29, 86.

Rhododendron obtusum japonicum hybri KURUME AZALEAS
Evergreen or semievergreen shrubs to 3 4 ft. Flowers in many shades of red a pink. April-May. (Zone 6). Sources: 23, 29, 38, 43, 81, 105, 112, MDTN.

Also GLENN DALE AZALEAS (based on **R. o tusum)**

Semievergreen shrubs to 3 or 4 ft. Flowe in many shades of red, pink and whit (Zone 6 to part Zone 5). Sources: 29, 3 81, 105, 109, MDTN.

Jetbead

Rhodotypos tetrapetala (scandens)
Deciduous shrub to 4 ft. or more. Fruits black, retained in winter. Flowers pure white 2 inches across. May-June. (Zone 4). Sources: 47, 48, 81, IOS, OHH.

Currant

Ribes aureum
GOLDEN CURRANT
Deciduous shrub to 4 or 5 ft. Flowers bright yellow in drooping racemes. April-May. (Zone 3). Sources: OHH.

Ribes odoratum
BUFFALO CURRANT
Deciduous shrub to 5 ft. Spreading. Flowers yellow, flushed reddish, fragrant, in nodding racemes. April-May. (Zone 4). Sources: OHH.

Ribes sanguineum 'King Edward VII'
Deciduous shrub to 5 ft. Young leaves aromatic. Flower crimson, in nodding racemes. March-April. (Zone 5). Sources: 113.

Locust

Robinia hispida
ROSE-ACACIA
Deciduous shrub to 3 ft., suckering. Stems bristly. Flowers rose-pink in nodding racemes. May-June. (Zone 5 to part Zone 4). Sources: OHH.

Robina kelseyi
KELSEY LOCUST
Deciduous shrub to 6 or 7 ft. with slender prickles. Flowers rose in 6- to 8-flowered nodding racemes. May-June. (Zone 5 to part Zone 4). Sources: OHH.

Robinia margarettae (pseudoacacia x hispida)
Deciduous shrub to 6 or 7 ft. Flowers light pink, in nodding racemes. May-June. (Zone 5). Sources: OHH.

Robinia neo-mexicana
Deciduous shrub to 4 or 5 ft. Flowers light rose-pink. June-July. (Zone 5). Sources:

Rose

Rosa carolina
CAROLINA ROSE
Suckering deciduous shrub to 2½ or 3 ft. Flowers rose-pink, 2 inches across. June-July. (Zone 4). Sources: NJPR, OHH.

Rosa hugonis
HUGO ROSE
Deciduous shrub to 5 or 6 ft. with arching branches. Flowers light yellow, 2 inches across. May-June. (Zone 5 to part Zone 4). Sources: 14, 54, 61, 71, 107, 113, 114, OHH.

Rosa moyesi
Deciduous shrub to 6 or 7 ft. with arching branches and handsome foliage. Flowers blood-red, 2 inches across. June. (Zone 5). Sources:

Rosa multiflora
Vigorous deciduous shrub to 5 ft. with long, arching branches and sharp prickles. Flowers white, less than 1 inch across, in pyramidal corymbs. June-July. (Zone 5 to part Zone 4). Sources: 47, 94, 114, MOW.

Rosa multiflora cathayensis
Flowers larger, pink. (Zone 5). Sources:

Rosa nitida
Deciduous shrub to 1½ ft. with bristly stems. Leaves shiny green. Flowers rose-pink to 2 inches across. June-July. Sources: NJPR, OHH.

Rosa omeiensis
Upright, deciduous shrub with large and conspicuous, flattened prickles. Flowers white, 1½ inch across. May-June. Leaves fern-like. (Zone 6 to part Zone 5). Sources:

Rosa pendulina
Deciduous shrub with slender, almost unarmed branches. Flowers rose or purplish. May-June. Fruits bright red. (Zone 4). Sources:

Rosa rugosa
Deciduous shrub to 4 or 5 ft. with large, dark green leaves. Stems bristly and prickly. Flowers 3 inches across, red, pink or white. June-July. Many varieties and hybrids. (Zone 3 to part Zone 2). Sources: 4, 35, 48, 54, 61, 71, 114, MOW, OHH.

Rosa spinosissima altaica
BURNETT ROSE
Upright, deciduous shrub to 4 or 5 ft. (more vigorous than the species). Flowers white, 2½ inches across. May-June. (Zone 4). Sources:

Rosa spinosissima hybrids
With white or pink, single or double flowers. Shrubs to 3 ft. Sources: OHH.

Brambles

Rubus deliciosus
BOULDER RASPBERRY
Deciduous shrub to 6 or 7 ft. with handsome, heart-shaped leaves. Flowers white, 2 inches across, very showy. May-June. (Zone 4). Sources:

Rubus odoratus
FLOWERING RASPBERRY
Deciduous, upright shrub to 6 or 7 ft. with large leaves. Flowers purplish-red, fragrant. 1½ inch across. June-August. (Zone 3). Sources: OHH.

Willow

Salix caprea
European Goat Willow
Shrub to 10 ft. or more. Flowers bright yellow in rather large catkins. March-April. (Zone 4). Sources: 43, 48, 67, 113, CSN.

Salix discolor
American Pussy Willow
Shrub to 10 ft. or small tree. Leaves bluish underneath. Male catkins bright yellow. March-April. (Zone 3 to part Zone 2). Sources: 66, 76, 81, 96, 101, 114.

Salix gracilistyla
Korean Rose-Gold Pussy Willow
Upright shrub to 6 or 7 ft. Leaves bluish-gray underneath. Male catkins rather large, bright yellow. March-April. (Zone 5 to part Zone 4). Sources: MDTN.

Sophora

Sophora viciifolia
Graceful, deciduous shrub to 4 or 5 ft. Best in dry, sandy soils. Flowers bluish-violet in upright racemes, freely produced. June. (Zone 5). Sources:

False-Spirea

Sorbaria aitchisoni
Kashmir False-Spirea
Upright, deciduous shrub to 6 or 7 ft. with red stems and graceful foliage. Flowers white in upright panicles. July-August. (Zone 5). Sources: OHH.

Sorbaria arborea glabrata
Spreading deciduous shrub to 10 or 12 ft. Branchlets purplish. Flowers white in large panicles. July-August. (Zone 5 to part Zone 4). Sources: OHH.

Sorbaria tomentosa
Spreading, deciduous shrub to 10 ft. or more. Flowers white in large, usually nodding panicles. July-August. (Zone 7 to part Zone 6). Sources: OHH.

Spirea

Spiraea arguta (thunbergi x multiflora)
Garland Spirea
Graceful deciduous shrub to 5 ft. Flowers white in umbels, all along the branches. May. (Zone 4). Sources: 1, 32, 48, 103, 114, IOS, OHH.

Spiraea billiardi (douglasi x salicifolia)
Billiard's Spirea
Upright, deciduous shrub to 4 or 5 ft. Leaves grayish beneath. Flowers bright rose in dense, upright panicles. June-August. (Zone 3). Sources: 38, 43, 53, 66, 96, 112, IOS, OHH, PAFA.

Spiraea bumalda (japonica x albiflora)
Dense, upright shrub to 2½ ft. Flowers bright crimson in almost flat corymbs. June-July. (Zone 3). Selected types: **'Anthony Waterer'** and **'Froebeli.'** Sources: 103, IOS, OHH.

Spiraea cantoniensis (reevesiana)
Reeve's Spirea
Deciduous shrub to 5 ft. with arching branches and dark green leaves. Flowers white, ½ inch across in dense umbels. June-July. (Zone 6). Sources: 42, 48, 53, 66.

Spiraea cantoniensis lanceata
Flowers double, white. Sources:

Spiraea gemmata (mongolica)
Snow-Bank Spirea
Deciduous shrub with slender branches to 4 or 5 ft. Flowers white in umbels. April-May. (Zone 5 to part Zone 4). Sources:

Spiraea japonica atrosanguinea (coccinea)
Deciduous shrub to 3 ft. Flowers bright crimson. June-July. (Zone 5). Sources: 113.

Spiraea nipponica rotundifolia
Nippon Spirea
Deciduous shrub to 6 or 8 ft. with small dark green leaves. Flowers white, in showy umbel-like racemes. June-July. (Zone 4) Sources: OHH.

Spiraea prunifolia plena
Bridal Wreath Spirea
Deciduous shrub to 6 or 7 ft. Flowers white double in showy umbels. April-May. (Zone 5). Sources: 1, 37, 38, 71, 114.

Spiraea 'Rosabella' (hybrid of S. betulifolia)
Deciduous shrub to 1¼ ft. Flowers pink in large, flat umbels. June-July. (Zone 3) Sources: CMD.

Spiraea 'Snow White' (trichocarpa x trilobata)
Deciduous shrub to 4 ft. Flowers white freely produced. June-July. (Zone 4 to part Zone 3). Sources: CMD.

Spiraea 'Summer Snow' (betulifolia x media)
Deciduous shrub to 2 or 2½ ft. Flowers white in flat panicles. June-August. (Zone 3). Sources: CMD.

Spiraea syringaeflora (albiflora x salicifolia)
Lilac Spirea
Deciduous shrub to 3 or 4 ft. Flowers lilac pink in pyramidal panicles. June-July (Zone 4). Sources:

Spiraea thunbergi
Thunberg's Spirea
Graceful, deciduous shrub to 5 ft. with slender branches. Leaves turn orange and scarlet in fall. Flowers pure white all along the branches. April-May. (Zone 4). Sources 47, OHH.

Spiraea trichocarpa
KOREAN SPIREA
Deciduous shrub to 4 ft. or more with spreading branches. Flowers white in compound umbels. June-July. (Zone 4 to part Zone 3). Sources: CSN, OHH.

Spiraea trilobata
THREELOBE SPIREA
Deciduous shrub to 3 or 4 ft. with slender, spreading branches. Flowers white in large umbels all along the branches. May-June. (Zone 4 to part Zone 3). Sources: OHH.
Selected type: **'Swan Lake.'** Sources: 113.

Spiraea vanhouttei (cantoniensis x trilobata)
Deciduous shrub to 5 or 6 ft. Leaves dark green, bluish beneath. Flowers white in umbels all along the branches. May-June. (Zone 4). Sources: 47, CSN, OHH.

Spiraea veitchi
Deciduous shrub to 7 ft. or more with long arching branches. Flowers white in dense corymbs. June-July. (Zone 5 to part Zone 4). Sources: OHH.

Stewartia

Stewartia ovata grandiflora
Deciduous shrub to 10 ft. or more with 3-5 inch long leaves. Flowers white with orange anthers, cup-shaped, to 3 inches across. July-August. (Zone 5). Sources:

Snowbell, Storax

Styrax japonica
JAPANESE SNOWBELL
Deciduous shrub to 15 or 20 ft. or small tree. Flowers white, bell-shaped, pendulous. Freely produced. June-July. (Zone 5). Sources: 28, 47, 66, 91, 102, OHH.

Styrax wilsoni
WILSON'S SNOWBELL
Deciduous shrub to 5 or 6 ft. Flowers white, bell-shaped, smaller than *S. japonica* but produced even on very small plants. May-June. (Zone 6). Sources:

Lilac

Syringa chinensis (persica x vulgaris)
CHINESE LILAC
Deciduous shrub to 10 ft. with rather slender branches. Flowers purple-lilac or white in loose panicles. May. (Zone 4). Sources: 49, 61, 63, 110, 114, IOS, OHH.

Syringa henryi (Lutèce) (villosa x josikaea)
Deciduous shrub to 8 ft. Flowers violet-purple in loose panicles. May-June. (Zone 4). Sources: 110, OHH.

Syringa microphylla
LITTLELEAF LILAC
Deciduous shrub to 5 or 6 ft. with slender branches and small leaves. Flowers lilac-pink, buds dark red in loose panicles. June. (Zone 5). Sources: 110, OHH.
Selected type: **superba.** Sources: 113, CSN.

Syringa oblata dilatata
KOREAN LILAC
Deciduous shrub to 8 ft. or more. Flowers pale lilac to purple-lilac. April-May. (Zone 4 to part Zone 3). Sources: 63.

Syringa pekinensis
PEKING LILAC
Deciduous shrub to 10 or 12 ft. with spreading branches. Flowers creamy-white in large panicles, not with lilac fragrance. June. (Zone 4). Sources: 110, OHH.

Syringa persica
PERSIAN LILAC
Deciduous shrub to 6 ft. with lobed leaves. Flowers pale lilac or white, fragrant. May. (Zone 4 to part Zone 3). Sources: 16, 33, 38, 47, 48, 49, 62, 63, 66, 96, 101, 114, OHH.

Syringa prestoniae (reflexa x villosa)
Shrub to 10 ft. or more. Flowers purple-lilac in upright panicles. May-June. Several named selections. (Zone 4 to part Zone 3). Sources: 63, CSN, OHH.

Syringa pubescens
Shrub to 5 ft. with slender branches and dark green, round leaves. Flowers pale lilac, fragrant in dense panicles. April-May. (Zone 5 to part Zone 4). Sources: OHH.

Syringa reflexa
NODDING LILAC
Shrub to 8 or 10 ft. with stout, purplish-gray branches. Flowers carmine in bud, later pink outside and white inside, in pendulous panicles. June. (Zone 4). Sources: 14, 63, 110, CSN, OHH.

Syringa skinneri (velutina x pubescens)
Shrub to 6 or 7 ft. Flowers pale mauve in bud, changing to white in pyramidal panicles, fragrant. May. (Zone 4 to part Zone 3). Sources: CMD.

Syringa swegiflexa (sweginzowi x reflexa)
PINK PEARL LILAC
Shrub to 8 ft. Flowers deep red in bud, changing to pink or lilac in large, dense panicles. June. (Zone 4 to part Zone 3). Sources: 113.

Syringa velutina (palibiniana)
Shrub to 6 or 8 ft. with small leaves. Flowers lilac in 6- to 8-inch-long panicles. May. (Zone 4 to part Zone 3). Sources: 113.

Syringa villosa
Shrub to 8 ft. with stout branches. Flowers rosy-lilac or whitish in dense panicles. May-June. (Zone 3). Sources: 4, 48, 61, 76, 96, 114, CSN, IOS, OHH.

Selection of Syringa vulgaris hybrids

White single: **'Vestale.'** Sources: 110, 113.

White double: **'Edith Cavell.'** Sources: 114, CSN.

Violet single: **'De Miribel.'** Sources: 36.

Violet double: **'Violetta.'** Sources: 63.

Blue single: **'President Lincoln.'** Sources: 6, 48, 49, 54, 56, 63, 70, 110, 114.

'Firmament.' Sources: 113.

Blue double: **'Olivier de Serres.'** Sources: 63, 110.

'Ami Schott.' Sources: 110, 113.

Lilac single: **'Marengo.'** Sources:

Lilac double: **'Victor Lemoine.'** Sources: 63, 110.

'Capitaine Perrault.' Sources: 110, 113.

Pink single: **'Lucie Baltet.'** Sources: 22, 63, 70, 91, 110.

'Esther Staley.' Sources: 113, CSN.

Pink double: **'Katherine Havemeyer.'** Sources: 1, 4, 6, 36, 37, 48, 54, 66, 76, 91, 110.

'Henri Martin.' Sources: 113.

Carmine-rose single: **'Marechal Foch.'** Sources: 56, 63, 113.

Carmine-rose double: **'Mrs. Edward Harding.'** Sources: 6, 113.

Purple single: **'Ludwig Spaeth.'** Sources: 1, 6, 22, 36, 37, 49, 54, 56, 62, 66, 76, 96, 110, 114, OHH.

'Mrs. W. E. Marshall.' Sources: 113.

Purple double: **'Alice Eastwood.'** Sources: 113.

Other hybrid Lilacs. Sources: 3 (New Hampshire hybrids), 110, OHH.

Tamarisk

Tamarix gallica
FRENCH TAMARISK
Shrub to 10 ft. or more with bluish foliage and arching branches. Flowers rose pink in dense racemes. June-August. (Zone 5 to part Zone 4). Sources:
Selected type: **'Summerglow.'**
Very free flowering. Sources: 113.

Tamarix odessana
ODESSA TAMARISK
Shrub to 5 or 6 ft. Flowers pink in slender racemes. July-September. (Zone 5 to part Zone 4). Sources: 18, 71, IOS, OHH.

Tamarix pentandra
Shrub to 10 ft. or more. Flowers rosy-pink in dense racemes. (Zone 4 to part Zone 3). Sources: CSN.

Viburnum

Viburnum burkwoodi (carlesi x utile)
Semievergreen shrub to 4 or 5 ft. Flowers white, flushed pink, fragrant. April-May. (Zone 5). Sources: OHH, WBC.

Viburnum carlcephalum (carlesi x macrocephalum)
Deciduous shrub to 7 ft. Leaves color brightly in fall. Flowers white, fragrant in very large, round heads. End of May to early June. (Zone 5). Sources: 7, 28, 86, 91, 113.

Viburnum carlesi
KOREAN SPICE VIBURNUM
Deciduous shrub to 4 ft. Leaves retained late in fall. Flowers white, pink outside, very fragrant. April-May. (Zone 4). Sources: 113, OHH, WBC.

Viburnum fragrans
Deciduous shrub to 6 or 7 ft. Leaves retained late in fall. Flowers with purplish stalks, pink in bud, later white, very fragrant. April-May. (Zone 5). Sources: OHH.

Viburnum fragrans album
Flowers white. March-April. (Zone 6). Sources:

Viburnum fragrans nanum
Only 3 or 4 ft. tall. (Zone 6). Sources: WBC.

Viburnum macrocephalum sterile
CHINESE SNOWBALL
Semievergreen shrub to 8 ft. or more. Flowers white, all sterile in very large, round heads. May-June. (Zone 6 to part Zone 5). Sources: 14, 20, 63, WBC.

Viburnum rhytidophyllum roseum
PINK LEATHERY VIBURNUM
Evergreen shrub to 7 or 8 ft. with large, shiny, dark green leaves. Flowers bright pink in bud, creamy-white when open. May-June. (Zone 6 to part Zone 5). Sources:

Viburnum sieboldi
SIEBOLD'S VIBURNUM
Shrub to 15 ft. or more with shiny, dark green leaves. Flowers creamy-white. May-June. Berries changing from pink to blue-black. (Zone 5 to part Zone 4). Sources: 49, 63, 70, 81, 91, OHH.

Viburnum tomentosum
Deciduous shrub to 7 ft. with horizontally spreading branches and dark green leaves. Flowers white with sterile marginal flowers. May-June. (Zone 4). Sources: OHH.

Viburnum tomentosum mariesi
Sterile flower heads larger. Sources: 63, 113, 114.

Viburnum tomentosum 'Pink Beauty'
Flowers open white and change to pink. Sources: 113.

Viburnum tomentosum sterile (plicatum)
JAPANESE SNOWBALL
All flowers sterile in round heads. (Zone 4). Sources: 7, 12, 17, 37, 62, 81, 91, 113, CSN, OHH.

Chaste-Tree

Vitex agnus-castus
CHASTE-TREE
Deciduous shrub to 7 ft. Leaves grayish-green of pungent aromatic odor. Flowers lilac or violet, fragrant in panicled spikes. July-September. (Zone 6 to part Zone 5). Sources: 32, 38, 60, 66, 91, 109, IOS, MDTN, OHH.

Vitex agnus-castus alba
Flowers white. Sources: 38, OHH.

Vitex agnus-castus latifolia (V. macrophylla)
Flowers lilac. (Zone 5). Sources: 113.

Weigela

Weigela floribunda hybrids
Deciduous shrub to 6 or 7 ft. (Zone 5 to part Zone 4).
'Bristol Ruby.'
Flowers bright ruby-red to crimson, May-July. Sources: 1, 17, 37, 49, 80, 113, IOS.
'Eva Rathke.'
Flowers bright red. May-July. 5 ft. Sources: 4, 12, 17, 32, 36, 47, 49, 50, 53, 60, 61, 66, 81, 114, OHH.
'Vaniceki.' ('Newport Red')
Flowers red. May-July. 6 ft. Sources: 33, 35, 49, 56, 60, 62, 66, 76, 81, 91, 114, OHH, PAFA.

Weigela hortensis hybrids
Shrubs to 5 or 6 ft. (Zone 5).
'Avalanche.'
Flowers pure white. May-June. Sources: 113.
'Fairy.'
Flowers light pink. May-June. Sources: 113.
Other Weigelas. Sources: OHH.

Yellowhorn

Xanthoceras sorbifolium
Deciduous shrub to 12 ft. or small tree with shiny, dark green leaves. Flowers white with a reddish blotch at base, about 1 inch across, in upright racemes. April-May. (Zone 6 to part Zone 5). Sources: WBC.

Buhle

Chaste-tree (*Vitex agnus-castus*) blooms in late summer

SHRUBS PLANTED FOR FOLIAGE AND FRUITS

Medium-size Evergreen Conifers for Foliage Effects

Fir

Abies concolor conica
Conical Colorado Fir
Slow-growing, densely pyramidal form to 6 ft. or more with rather short needles. (Zone 4). Sources:

Plum-Yew

Cephalotaxus drupacea
In cultivation, a spreading shrub to 8 or 10 ft. or more with dark green foliage. (Zone 6 to part Zone 5). Sources: MDTN.

Cephalotaxus drupacea fastigiata
Broadly columnar to 12 ft. (Zone 6). Sources: MDTN.

False-Cypress

Chamaecyparis lawsoniana fletcheri
Slowly growing, densely columnar form to 6 or 8 ft. Bluish-green. (Zone 6). Sources: 63.

Chamaecyparis obtusa compacta
Hinoki Cypress
Dense, broadly conical form to 8 or 10 ft. Slow growing. Dark green. (Zone 4). Sources: 28, OHH, PAFA.

Chamaecyparis obtusa filicoides
Of irregular growth to 12 ft. or more. Slow growing. Branches fernlike. Dark green. (Zone 5 to part Zone 4). Sources: 14, 63.

Chamaecyparis pisifera filifera aurea
Sawara Cypress
Broadly pyramidal or spreading shrub to 10 ft. or more. Slow growing. Branches threadlike, golden-yellow. (Zone 4 to part Zone 3). Sources: OHH.

Chamaecyparis pisifera plumosa
Plume Sawara Cypress
Broadly conical to 20 ft. or more or irregularly shrubby with feathery twigs. Green. (Zone 4 to part Zone 3). Sources: 28, 29, 36, 43, 47, 54, 61, 62, 81, 114, IOS, OHH.

Chamaecyparis pisifera squarrosa cyanoviridis
Moss Sawara Cypress
Irregular bushy to 20 ft. or more. Bluish-grayish-green. (Zone 4). Sources: 14, 63, 75.

Cryptomeria

Cryptomeria japonica compacta
Compactly conical to 20 or 25 ft. Bluish-green. (Zone 6 to part Zone 5). Sources:

Juniper

Juniperus chinensis globosa (J. virginalis)
Globe Chinese Juniper
Densely globose to broadly conical. 3 to 4 ft. Bright green. (Zone 6 to part Zone 5). Sources: ILHD, OHH.

Juniperus chinensis hetzi
Hetz Blue Chinese Juniper
Spreading shrub to 4 ft. Bluish-green. (Zone 5 to part Zone 4). Sources: OHH, PAFA.

Juniperus chinensis mas
Columnar Chinese Juniper
Densely narrow conical or columnar to 20 or 25 ft. Green or slightly bluish. (Zone 5 to part Zone 4). Sources:

Juniperus chinensis pfitzeriana
Pfitzer Juniper
Shrubby with spreading branches or broadly pyramidal to 6 or 8 ft. Green. (Zone 4). Sources: ILHD, NJPR, OHH.

Juniperus chinensis pfitzeriana aurea
Golden Pfitzer Juniper
To 5 or 6 ft. Golden-yellow. (Zone 4). Sources: ILHD.

Juniperus chinensis pfitzeriana compacta
Slower growing and more compact. 4 to 5 ft. Green. (Zone 4). Sources: CSN, OCN.

Juniperus communis hibernica (stricta)
Irish Juniper
Columnar or narrowly conical to 10 or 12 ft. Dark green. (Zone 5). Sources: 6, 31, 43, 47, 48, 79, 80, 86, 88, 112, IOS, ILHD, OHH.

Juniperus communis suecica nana
Dwarf Swedish Juniper
Compact conical. Slow growing to 5 or 6 ft. Bluish-green. (Zone 4). Sources: PAFA.

Juniperus communis depressa 'Vase-Shaped'
Spreading shrub with arching branches to 6 ft. Bluish-green. (Zone 4 to part Zone 3). Sources: OHH.

Juniperus excelsa stricta
Columnar Greek Juniper
Narrowly conical or columnar. Slow growing to 6 or 8 ft. Bluish-gray. (Zone 7 to part Zone 6).
Commonly confused with the much hardier *J. chinensis pyramidalis*. Sources: 6, 36, 42, 47, 48, 53, 66, PAFA.

'uniperus sabina 'Von Ehron'
Spreading shrub to 4 or 5 ft. with spreading branches. Light green. (Zone 4 to part Zone 3). Sources: ILHD, OHH.

'uniperus squamata meyeri
MEYER'S JUNIPER
Picturesque upright, irregularly branched shrub to 4 ft. Silvery-blue. Getting straggly when old. (Zone 4). Sources: 6, 12, 22, 49, 0, 85, 114, ILHD, OHH.

'uniperus virginiana globosa
GLOBE RED CEDAR
Densely globular to 4 ft. Fresh green. Zone 4 to part Zone 3). Sources: OHH.

'uniperus virginiana kosteri
KOSTER'S RED CEDAR
Spreading shrub with ascending branches o 4 or 5 ft. Bluish. (Zone 4). Sources:)HH.

'uniperus virginiana tripartita
'OUNTAIN RED CEDAR
Spreading shrub to 5 ft. with ascending branches and drooping tips. Bluish-green. Sources: OHH.

For other Junipers, see Evergreen Trees nd Dwarf Conifers

Spruce

Picea abies (excelsa) **clanbrasiliana**
Compact, cushion-forming, slow growing to ft. Bright green. (Zone 3). Sources: 4, 63, 75, 102, OHH.

Picea abies compacta
Densely, broad-conical, slow growing to 4 or ft. Bright green. (Zone 3). Sources:

Picea abies ellwangeriana
Broadly pyramidal with crowded branches o 7 or 8 ft. Dark green. (Zone 3). Sources:)HH.

Picea abies microsperma
Densely conical to 6 ft. or more with crowded, ascending branches. Light green. (Zone). Sources: 63.

Picea abies ohlendorfi
Broadly conical to 7 or 8 ft. Yellowish-reen. (Zone 3). Sources: 63.

Picea abies parviformis
Bushy or broadly pyramidal to 7 ft. Bright reen. (Zone 5 to part Zone 4). Sources:)HH.

Picea abies remonti
Densely pyramidal or oval to 6 ft. Light reen. (Zone 4). Sources: 63, OHH.

Picea engelmanni microphylla
DWARF ENGELMANN SPRUCE
Densely globular to 6 ft. or more. Grayish-reen. (Zone 4). Sources:

Picea glauca conica
Densely conical, slow growing to 8 ft. or nore. Light bluish-green. (Zone 3). Sources: 8, 53, 71, 81, 91, 102, 114, ILHD, OHH.

Picea omorika nana
DWARF SERBIAN SPRUCE
Very broadly conical to 4 or 6 ft. The bluish underside of the needles very conspicuous. (Zone 4 to part Zone 3). Sources: CSN.

Picea orientalis nana
DWARF ORIENTAL SPRUCE
Very broadly pyramidal to 5 or 6 ft. Dark green. (Zone 5). Sources: CAG.

Picea pungens glauca 'Montgomery'
Broadly pyramidal, slow growing to 5 or 6 ft. Bluish. (Zone 3). Sources: 63.

For other Spruces, see Evergreen Trees and Dwarf Conifers

Pine

Pinus densiflora umbraculifera
JAPANESE UMBRELLA PINE
Densely umbrella-shaped, slow growing to 10 ft. Bluish-green. (Zone 4 to part Zone 3). Sources: OHH.

Pinus mugo mughus
SWISS MOUNTAIN PINE
Dense, slow-growing shrub, eventually to 12 ft. or more. Dark green. (Zone 3). Sources: OHH.

Pinus strobus nana (pumila)
DWARF WHITE PINE
Broadly bushy to 4 or 6 ft. Bluish-green. (Zone 3). Sources: 14, 28.

Pinus strobus umbraculifera
UMBRELLA WHITE PINE
Densely umbrella-shaped. Developing a short trunk. 10 to 12 ft. (Zone 3). Sources: 14, 28.

Pinus sylvestris watereri (pumila)
PYRAMIDAL SCOTS PINE
Densely broad pyramidal to 10 ft. Steel-blue. (Zone 3). Sources: 14, 63.

For other Pines, see Evergreen Trees and Dwarf Conifers

Yew

Taxus baccata adpressa
ENGLISH YEW
Irregularly broad, bushy to 8 ft. Dark green. (Zone 5 to part Zone 4). Sources: 63.

Taxus baccata compacta
Globular to 3 or 4 ft. Dark green. (Zone 5). Sources: MDTN.

Taxus baccata erecta
Upright bushy to 8 ft. Grayish-green. (Zone 5). Sources: 74, OHH.

Taxus baccata washingtoni
Broadly spreading to 5 or 6 ft. with arching tips. Light green. (Zone 5). Sources: OHH.
Other varieties of **T. baccata**
Source: MDTN.

Taxus cuspidata nana
JAPANESE YEW
Shrub with wide spreading branches to 6 ft. or more. Dark green. (Zone 4). Sources: 7, 14, 18, 28, 37, 54, 61, 62, 63, 71, 76, 81, 109, ILHD, OHH.

Taxus cuspidata pyramidalis
Compact and broadly pyramidal to 8 or 10 ft. Dark green. (Zone 4). Sources: ILHD, OHH, PAFA.

Taxus cuspidata thayerae
Wide-spreading shrub to 4 ft. Fruiting freely. Light green. (Zone 4). Sources: 63, 91.
Other named varieties of **Taxus cuspidata** Sources: MDTN, PAFA.

Taxus hunnewelliana (cuspidata x canadensis)
Upright and slender to 10 ft. Lighter green than *T. cuspidata.* (Zone 4). Sources: 49, 63, MDTN, OHH.

Taxus media (cuspidata x baccata) **hatfieldi**
Compact conical or pyramidal to 5 or 6 ft. Dark green. (Zone 4). Sources: 18, 28, 48, 54, 62, 63, 71, 81, 91, 94, 109, 112, 113, 114, ILHD, MDTN, OHH.

Taxus media hicksi
Columnar to 6 ft. or more with ascending branches. (Zone 4 to part Zone 3). Sources: 47, ILHD, MDTN, PAFA.

Taxus media kelseyi
Densely, broadly columnar to 6 ft. Dark green. (Zone 4). Sources: 62, OHH, PAFA.
Other named forms of **T. cuspidata** and **media** Sources: 6, 37, 43, 47, 48, 49, 62, 63, 70, 71, 79, 81, 91, MDTN.

Arbor-Vitae

Thuja occidentalis compacta
Densely pyramidal, slow growing to 8 or 10 ft. Light green. (Zone 3 to part Zone 2). Sources: OHH, PAFA.

Thuja occidentalis cristata
Irregularly pyramidal to 10 or 12 ft. Branchlets crested. Grayish-green. (Zone 3). Sources: OHH.

Thuja occidentalis ellwangeriana
Broadly pyramidal to 8 or 10 ft. Branchlets feathery. Light green. (Zone 3 to part Zone 2). Sources: OHH.

Thuja occidentalis ericoides
HEATH ARBOR-VITAE
Broadly bushy to 4 or 5 ft. with slender, ascending branches. Dull green. (Zone 4). Sources: 47, OHH.

Thuja occidentalis globosa
TOM THUMB ARBOR-VITAE
Globular to 5 or 6 ft. Bright green. (Zone 3). Sources: 1, 6, 18, 22, 31, 33, 45, 47, 60, 62, 66, 70, 76, 79, 88, 91, 96, OHH.

Thuja occidentalis hoveyi
Globose to oval, to 5 or 6 ft. Light green. (Zone 3). Sources: 31, 71, OHH.

Thuja occidentalis rosenthali
Columnar to 12 ft. or more. Shiny dark green. (Zone 3). Sources: 6, 61, 71, 81, OHH.

Thuja occidentalis umbraculifera
Broadly umbrella-shaped to 4 or 5 ft. Bluish. (Zone 3 to part Zone 2). Sources: OHH.

Thuja occidentalis vervaeneana
Slender conical to 15 ft. or more. Light green, bronze-colored in winter. (Zone 3 to part Zone 2). Sources: OHH.

Thuja occidentalis woodwardi
Densely globose to 5 ft. Dark green summer and winter. (Zone 3). Sources: 12, 51, 71, 74, 79, 81, 88, 114, ILHD, OHH.

Thuja orientalis aurea (aurea nana)
Broadly rounded. Slow growing to 5 ft. Golden-yellow in spring. (Zone 6). Sources: 6, 12, 32, 36, 37, 38, 42, 49, 50, 53, 59, 66, 74, 81, 91, 114, OHH.

Thuja orientalis elegantissima
Broadly columnar to 10 or 12 ft. Bright yellow in spring. (Zone 6 to part Zone 5). Sources: OHH.

Thuja orientalis sieboldi
Round and bushy to 4 ft. Fresh green. (Zone 6 to part Zone 5). Sources: OHH.

Thuja plicata rogersi
Densely conical to 3 or 5 ft. Golden yellow. (Zone 5). Sources: CAG.

Hemlock

Tsuga canadensis compacta
Broadly conical to 5 or 6 ft. (Zone 4). Sources: 14.

Tsuga canadensis dawsoniana
Very broad pyramidal to 10 or 15 ft. (Zone 4). Sources:

Tsuga canadensis fremdi
Conical. Slow growing to 8 or 10 ft. Dark green. (Zone 4). Sources: 14, 63.

Tsuga canadensis globosa
Globular to 3 or 4 ft. (Zone 4). Sources: 63.

Tsuga canadensis microphylla (parvifolia)
Graceful with small needles, rather slow growing, 15 to 25 ft. (Zone 4). Sources: 63, 114.

Tsuga caroliniana compacta (globosa)
Round-headed, dense, slow growing to 8 ft. or more. (Zone 5). Sources:

Medium-size Deciduous and Broadleaf-evergreen Shrubs Planted for Foliage and Fruits

Acanthopanax

Acanthopanax henryi
Upright shrub to 7 or 8 ft. with stout prickles and five-fingered leaves. (Zone 5). Sources: OHH.

Acanthopanax sieboldianus
Spreading shrub to 7 or 8 ft. with arching branches and five- to seven-fingered leaves. (Zone 4). Sources: OHH.

Maple

Acer ginnala
Amur Maple
Shrub to 12 ft. or more. The 3-lobed, shiny dark green leaves turn bright red in fall. (Zone 3 to part Zone 2). Sources: 56, 63, 70, 76, 96, OHH.

Acer glabrum
Rocky Mountain Maple
Shrub to 15 ft. or small tree. The shiny dark green leaves on reddish stalks turn bright yellow in fall. (Zone 5). Sources:

Acer japonicum
Japanese Maple
Graceful shrub to 15 ft. or small tree. Leaves bright green turning crimson in fall. (Zone 5). Sources: 63.

Acer japonicum aconitifolium (filicifolium)
Fernleaf Maple
Shrub to 8 or 10 ft. with deeply divided, fern-like leaves, turning red in fall. (Zone 5). Sources: OHH.

Acer japonicum aureum
Golden Moon Maple
Shrub to 10 or 12 ft. with bright yellow leaves. (Zone 6 to part Zone 5). Sources: OHH.

Acer palmatum
Japanese Maple
Shrub to 12 ft. or small tree, with deeply 5- or more-lobed leaves, turning crimson in fall. (Zone 4). Sources: 28, OHH.

Acer palmatum atropurpureum
To 10 ft. with deeply purplish-red leaves. (Zone 5 to part Zone 4). Sources: 47, OHH.

Acer palmatum dissectum
To 8 ft. with deeply dissected green leaves, turning crimson in fall. (Zone 4). Sources: 113.

Acer palmatum ornatum (dissectum atropurpureum)
To 6 ft. with deeply dissected red leaves. (Zone 5). Sources: MDTN, OHH.
Other named varieties of **A. palmatum** Sources: MDTN.

Acer sieboldianum
Siebold Maple
Shrub to 15 ft. or small tree with 7-9 lobed leaves turning red and orange in fall. (Zone 5). Sources:

Acer spicatum
Mountain Maple
Shrub to 15 ft., or small tree. Leaves turning orange and scarlet in fall. Flowers yellowish in upright spikes, conspicuous. June. Fruits red in August. (Zone 2). Sources: OHH.

Acer tataricum
Tatarian Maple
Shrub to 15 or 20 ft., or small tree. Leaves ovate, bright green, turning yellow in fall. (Zone 4 to part Zone 3). Sources: OHH.

Aralia

Aralia elata
Japanese Angelica Tree
Shrub-like in growth, to 15 or 25 ft. with stout, prickly stems and very large, dissected leaves. (Zone 4). Sources: OHH.

Chokeberry

Aronia arbutifolia
Red Chokeberry
Shrub to 7 or 8 ft. Leaves turn red in fall. The bright red berries persist through the winter. (Zone 4). Sources: 7, 18, 32, 36, 47, 48, 53, 54, 61, 66, 81, 88, 113, OHH.

Aronia melanocarpa
Black Chokeberry
Shrub to 3 or 4 ft. Leaves bright green, fruits shiny black. (Zone 4). Sources: 54, 66, 88, OHH.

Aronia melanocarpa elata
To 6 or 8 ft. with shiny, green leaves. Sources: OHH.

Aucuba

Aucuba japonica
Japanese Aucuba
Stout evergreen shrub to 10 ft. with glossy dark green leaves. (Zone 7). Sources: 12, 23, 32, 38, 53, 66, 86, 109.

Aucuba japonica variegata
Gold Dust Tree
Leaves bordered and spotted white or yellow. Sources: 12, 14, 23, 32, 38, 53, 66, 86. 86.

Benzoin

Benzoin (see **Lindera**)

Barberry

Berberis candidula
Paleleaf Barberry
Evergreen shrub to 3 ft. Leaves white beneath. (Zone 5). Sources: 63, OHH.

Berberis circumserrata
Deciduous shrub to 3 or 4 ft. Leaves spiny, turning scarlet in fall. Fruits light red. (Zone 5). Sources:

Berberis darwini
DARWIN'S BARBERRY
Graceful evergreen shrub to 5 ft. or more with shiny, dark green leaves. Flowers golden yellow, tinged red, in showy, pendulous racemes. March. (Zone 7). Sources:

Berberis gagnepaini
BLACK BARBERRY
Evergreen shrub to 5 ft. with bluish-black, bloomy berries. (Zone 6 to part Zone 5). Sources: 12, 47.

Berberis julianae
WINTERGREEN BARBERRY
Handsome evergreen shrub to 5 ft. Leaves dark green. Fruits bluish-black. (Zone 5). Sources: 47, OHH.

Berberis koreana
KOREAN BARBERRY
Deciduous shrub to 5 or 6 ft. Leaves turn dark red in fall. Berries bright red, long retained. (Zone 4 to part Zone 3). Sources: 14, 61.

Berberis mentorensis (julianae x thunbergi)
MENTOR BARBERRY
Semievergreen, upright shrub. Suitable for hedges. (Zone 5 to part Zone 4). Sources: 48, 49, 53, 59, 66, 86, 91, 113.

Berberis stenophylla (darwini x empetrifolia)
ROSEMARY BARBERRY
Graceful, evergreen shrub to 4 or 5 ft. Flowers golden yellow, conspicuous. March-April. (Zone 6). Sources:

Berberis thunbergi
JAPANESE BARBERRY
Spiny shrub to 6 ft. Excellent hedge plant. Leaves turn scarlet in fall. Berries bright red, long retained. (Zone 4). Sources: 47, OHH, PAFA.

Berberis thunbergi atropurpurea
RED JAPANESE BARBERRY
Leaves purplish red all summer. Somewhat more tender than *B. thunbergi*. (Zone 5). Sources: OHH, PAFA.

Berberis thunbergi erecta
UPRIGHT JAPANESE BARBERRY
Densely branched, strictly upright to 4 ft. Excellent for low hedges. (Zone 5 to part Zone 4). Sources: 70, 81, 86, OHH.

Berberis thunbergi 'Thornless'
Form without thorns, otherwise like *B. thunbergi*. Leaves turn scarlet in fall. (Zone 4). Sources: 113.

Berberis triacanthophora
THREESPINE BARBERRY
Evergreen shrub to 4 or 5 ft., branches slender, spreading. Leaves bluish beneath. Fruits black. (Zone 5). Sources: 12, 47.

Berberis verruculosa
WARTY BARBERRY
Evergreen shrub to 3 or 4 ft. Leaves glossy dark green. Fruits black. Flowers golden-yellow, showy. (Zone 6 to part Zone 5). Sources: 12, 14, 36, 37, 47, 50, 63, 75, 86, OHH.

Boxwood

Buxus microphylla
LITTLELEAF BOXWOOD
Evergreen, compact shrub to 3 or 4 ft., with small, round leaves. (Zone 6). Sources: 63.

Buxus microphylla japonica
Evergreen shrub to 5 ft. with spreading branches, light green. (Zone 6 to part Zone 5). Sources: MDTN.

Buxus sempervirens arborescens
COMMON TALL BOX
Dense evergreen shrub to 12 ft. or more. Leaves glossy green. (Zone 6 to part Zone 5). Sources: 12, 32, 54, 63, 109.

Buxus sempervirens argenteo-variegata
To 6 ft. Leaves white-variegated. (Zone 6). Sources: 14, 63, 102.

Buxus sempervirens glauca
To 5 ft. Leaves dull bluish-green. (Zone 6 to part Zone 5). Sources: VAGR.

Buxus sempervirens handsworthi
To 8 ft. Glossy dark green. (Zone 6 to part Zone 5). Sources: 47, 63, VAGR.

Buxus sempervirens pyramidata (fastigiata)
Broadly pyramidal to 10 ft. (Zone 6). Sources: MDTN.

For other Boxwood, see Dwarf Shrubs

Beauty-Berry

Callicarpa bodinieri giraldi
GIRALD'S JEWEL-BERRY, BODINIER BEAUTY BERRY
Deciduous shrub to 5 or 6 ft. Flowers pinkish-lilac. July-August. Berries violet-purple. September-October. (Zone 6 to part Zone 5). Sources: 47, 113, OHH.

Callicarpa dichotoma (purpurea, koreana)
KOREAN JEWEL-BERRY
Deciduous upright shrub to 4 or 5 ft. Berries lilac-violet. September-October. (Zone 5 to part Zone 4). Sources: 7, 18, 53, 60, 112, 114, IOS, OHH.

Callicarpa japonica
JAPANESE JEWEL-BERRY
Deciduous shrub to 4 ft. Fruits violet. October-November. (Zone 5). Sources: 4, 86, OHH.

Pea-Shrub

Caragana arborescens
SIBERIAN PEA-SHRUB
Upright deciduous shrub to 8 or 10 ft. or more. Excellent hedge plants. (Zone 3 to part Zone 2). Sources: 1, 49, 61, 70, 71, 81, 96, 114, OHH.

Caragana arborescens lorbergi
Graceful shrub to 8 ft. with linear leaflets. (Zone 3). Sources: OHH.

Caragana arborescens nana
To 4 or 5 ft. with contorted branches. (Zone 3). Sources:

Caragana frutex (frutescens) **globosa**
Densely globose shrub to 3 or 4 ft. (Zone 2). Sources: CMD.

Dogwood

Cornus alba sibirica
SIBERIAN DOGWOOD
Deciduous shrub to 5 or 6 ft. Branches bright coral red. (Zone 3 to part Zone 2). Sources: 7, 18, 36, 49, 70, 76, 101, OHH. Selected type: **'Coral Beauty.'** Sources: 113.

Cornus alba spaethi
Shrub to 5 ft. Leaves broadly edged yellow. Branches blood-red. (Zone 4). Sources: OHH.

Cornus sanguinea
RED DOGWOOD
Deciduous shrub to 8 ft. or more. Branches dark red. Leaves turn blood-red in fall. (Zone 4). Sources: NJPR, OHH.

Cornus sanguinea viridissima
Branches bright green. (Zone 4). Sources: OHH.

Cornus stolonifera flaviramea
YELLOW TWIG OSIER
Shrub to 5 or 6 ft. Branches bright yellow. (Zone 3). Sources: NJPR, OHH.

Hazelnut, Filbert

Corylus maxima purpurea
PURPLE-LEAFED FILBERT
Deciduous shrub to 10 or 12 ft. Leaves deep purplish-red. (Zone 5). Sources: 113.

Smoke-Tree

Cotinus coggygria purpureus
PURPLE SMOKE-TREE
Selected type: **'Notcutt.'** Deciduous shrub to 10 or 12 ft. Leaves deep bronze-purple. Fruiting plumes also dark purple. (Zone 4). Sources: 113.

Cotoneaster

Cotoneaster bullata floribunda (C. floribunda)
Deciduous shrub to 4 or 5 ft. Berries red in bunches. (Zone 5 to part Zone 4). Sources: 113.

Cotoneaster conspicua
Spreading evergreen shrub to 5 ft. Berries scarlet, freely produced. (Zone 7). Sources: 38, MDTN.

Cotoneaster dielsiana
Graceful shrub to 5 or 6 ft. Branches arching. Berries bright scarlet in great profusion. (Zone 5). Sources: 113, OHH.

Cotoneaster divaricata
Shrub to 5 or 6 ft. Leaves small, glossy dark green. Berries bright red. (Zone 5 to part Zone 4). Sources: 47, 113, OHH.

Cotoneaster foveolata
Shrub to 8 ft. Berries black. Leaves dark green turning scarlet and orange in fall. (Zone 4). Sources: OHH.

Cotoneaster francheti
Semievergreen shrub to 8 ft. Berries orange-red. (Zone 6 to part Zone 5). Sources: 18, 38, 47, 50, 53, 54, 63, 114.

Cotoneaster frigida
Semievergreen shrub to 12 ft. or small tree. Berries bright red in large clusters. (Zone 7). Source:

Cotoneaster hupehensis
Deciduous shrub to 5 ft. Berries bright red in clusters. (Zone 4 to part Zone 3). Sources:

Cotoneaster lucida
Upright deciduous shrub to 7 ft. or more with glossy dark green leaves. Berries black. Excellent hedge shrub. (Zone 4 to part Zone 3). Sources:

Cotoneaster multiflora calocarpa
Berries bright red, freely produced. See Flowering Shrubs

Cotoneaster racemiflora soongarica
Shrub to 6 ft. with arching branches. Berries red in clusters. (Zone 4 to part Zone 3). Sources: MDTN, OHH.

Cotoneaster salicifolia floccosa
Semievergreen shrub to 6 ft. Leaves glossy dark green. Berries bright red. (Zone 5). Sources: 20, 47, 63, OHH.

Cotoneaster wardi
Upright, semievergreen shrub to 6 ft. or more. Leaves silvery-white beneath. Berries bright red. (Zone 6). Sources: MDTN.

Hawthorn

Crataegus macrantha
Dense shrub to 10 or 12 ft. with slender spines and glossy dark green leaves. Berries glossy, cherry-red, freely produced. (Zone 4). Sources: OHH.

Crataegus sanguinea
Shrub to 12 ft. or more with spreading branches. Berries bright red. (Zone 3). Sources: CMD.

Elaeagnus

Elaeagnus commutata
SILVER BERRY
Unarmed, upright shrub to 8 ft. with silvery leaves and silvery berries. Suitable for hedges. (Zone 2). Sources: OHH.

Elaeagnus pungens
THORNY ELAEAGNUS
Spreading, spiny, evergreen shrub to 8 ft. with glossy dark green leaves. (Zone 7). Sources: 2, 12, 23, 38, 42, 53, 63, 109.
Varieties of *E. pungens.* Sources: 38, 42, 45, 53, 63, 109.

Elaeagnus umbellata
AUTUMN ELAEAGNUS
Deciduous shrub to 8 or 9 ft. with spiny branches. Leaves silvery beneath. Flowers pale yellowish, not very showy but fragrant. May-June. (Zone 4 to part Zone 3). Sources: 47, 53, 81, OHH.

Euonymus

Euonymus alata
WINGED SPINDLE-TREE
Deciduous shrub to 8 ft. with stiff corky branches. Leaves turn rosy-scarlet in fall. (Zone 3). Sources: OHH.
Selected type: **'Monstrosus.'** Branches more prominently corky. Sources: 47, 113.

Euonymus alata compacta
Dense shrub to 5 or 6 ft. Suitable for hedges. (Zone 3). Sources: 47, OHH.

Euonymus americana
STRAWBERRY-BUSH
Deciduous shrub to 6 or 7 ft. Fruits pink, covered with prickly warts. (Zone 5). Sources: OHH.

Euonymus atropurpurea
BURNING-BUSH
Deciduous shrub to 12 ft. or small tree. Fruits crimson. Leaves turn yellow and red in fall. (Zone 4). Sources: OHH.

Euonymus bungeana
WINTERBERRY EUONYMUS
Deciduous shrub to 12 ft. or more. Fruits pink, remaining into the winter. Leaves turn yellow. (Zone 4 to part Zone 3). Sources: OHH.

Euonymus europaea aldenhamensis
ALDENHAM SPINDLE-TREE
Deciduous shrub to 8 ft. or more. Fruits bright red, freely produced. Leaves dark green until late fall. (Zone 4 to part Zone 3). Sources: 49, 113, 114.

Euonymus fortunei carrieri
GLOSSY WINTER CREEPER
Spreading evergreen shrub to 4 ft. with glossy dark green leaves. Climbing if supported. Fruits orange, long retained. (Zone 5). Sources: 51.
Selected type: **'Emerald Cushion.'** Sources: 1, 91.

Euonymus fortunei gracilis (argenteo-marginata)
SILVER-EDGE WINTER CREEPER
Evergreen spreading shrub to 3 or 4 ft. Leaves margined white. (Zone 5). Sources: OHH.

Euonymus fortunei vegeta
BIGLEAF WINTER CREEPER EUONYMUS
Spreading evergreen shrub to 4 or 5 ft. Climbing if supported. Leaves larger, dull green, fleshy. Fruits orange, freely produced, long retained. (Zone 5 to part Zone 4). Sources: 47, OHH.

For the creeping forms of **E. fortunei,** see Dwarf Plants.

Euonymus japonica
JAPANESE EVERGREEN EUONYMUS
Upright evergreen shrub to 10 ft. or more with glossy dark green leaves. (Zone 7 to part Zone 6). Sources: 2, 12, 23, 28, 53, 91.

Euonymus japonica albo-marginata
Leaves margined white. Sources: 12.

Euonymus kiautschovica (patens)
Half-evergreen, spreading shrub to 6 ft. Fruits pink on slender stalks. (Zone 6 to part Zone 5). Sources: 113, OHH.

Euonymus latifolia
BROADLEAF EUONYMUS
Deciduous shrub to 8 or 10 ft. or more. Leaves rather large. Fruits large, bright red. (Zone 5 to part Zone 4). Sources:

Euonymus maacki
Deciduous shrub to 10 or 12 ft. or small tree. Fruits pink. (Zone 4 to part Zone 3). Sources: OHH.

Euonymus sachalinensis (planipes)
Deciduous shrub to 7 or 8 ft. Fruits rather large, bright red, on slender stalks in clusters. Freely produced. (Zone 5). Sources:

Euonymus yedoensis
YEDDO EUONYMUS
Deciduous shrub to 10 ft. or more. Fruits pink, freely produced. (Zone 4). Sources: 1, 22, 71, 76, 114, OHH.

Sea-Buckthorn

Hippophae rhamnoides
SAND-THORN
Deciduous, spiny shrub to 12 ft. Leaves silvery. Berries orange and conspicuous but malodorous. Suitable for hedges. (Zone 2). Sources: 113.

Holly

Ilex aquipernyi (aquifolium x pernyi)
Evergreen shrub to 12 ft. or more with spiny-toothed, glossy dark green leaves. (Zone 7 to part Zone 6). Sources: 15, 30, 63, 109.
Selected type: **'Brilliant'** with freely produced, bright red berries. Sources: MDTN

Ilex cassine
DAHOON
Evergreen shrub to 10 ft. or more with rather small, roundish leaves. Berries red. (Zone 7). Sources: 15, 48, 53.

Ilex ciliospinosa
CHINESE HOLLY
Broadly pyramidal evergreen shrub to 8 ft. or more with 1-2 inch, spiny-toothed leaves. Berries red. (Zone 7 to part Zone 6). Sources:

Ilex cornuta
Evergreen shrub, slow growing to 6 or 8 ft. Leaves glossy, spiny, almost rectangular. Berries bright red, very showy. (Zone 6 to part Zone 5). Sources: 15, 23, 32, 38, 42, 47, 63, 66, OHH.

Ilex cornuta burfordi
Leaves less spiny. Hardier than the type. (Zone 5). Sources: 15, 23, 30, 32, 38, 42, 43, 45, 47, 53, 63, 66, 81, 86, 105, MDTN.

Ilex cornuta rotunda
Spreading and slow growing to 3 or 4 ft. (Zone 6 to part Zone 5). Sources: 15, 23, MDTN.
Other varieties of **I. cornuta**
Sources: 23, MDTN.

Ilex crenata
JAPANESE HOLLY
Densely branched, small-leaved, evergreen shrub to 10 ft. or more. Berries black. (Zone 5). Sources: 38, 47, MDTN, OHH.

Ilex crenata convexa (bullata)
Upright to 8 ft. or more. With convex, glossy dark green leaves. Suitable for hedges. Sources: 38, 47, 113, MDTN, OHH, PAFA.

Ilex crenata helleri
Compact and slow growing to 4 ft. Leaves small, roundish. (Zone 5). Sources: 15, 23, 36, 38, 47, 63, 66, 81, 105, 109, MDTN.

Ilex crenata hetzi
Compact, slow growing to 4 ft. with convex leaves. Sources: 43, 49, 105, MDTN, PAFA.

Ilex crenata latifolia
To 10 ft. with comparatively large leaves. (Zone 5). Sources: OHH.

Ilex crenata microphylla
To 6 ft. Densely branched with small leaves. Excellent for hedges. (Zone 5). Sources: 47, 63, 81, 105, MDTN, OHH.

Ilex crenata nummularia (mariesi)
To 3 ft. with crowded, round leaves. (Zone 6). Sources: 75.

Ilex crenata rotundifolia
Compact to 5 or 6 ft. (Zone 5). Sources: 47, 113, MDTN, OHH, PAFA.
Other varieties of **I. crenata**
Sources: MDTN.

Ilex geniculata
Deciduous shrub to 6 or 7 ft. Berries bright red on pendulous stalks. Leaves turn yellow in fall. (Zone 5). Sources:

Ilex glabra
INKBERRY
Half-evergreen or evergreen shrub to 5 or 6 ft. with glossy dark green leaves and black berries. (Zone 4). Sources: 7, 15, 23, 32, 36, 37, 47, 49, 71, 81, 91, 109, 113, 114, MDTN, OHH.

Ilex glabra compacta
Densely branched to 3 ft. Sources: 14.

Ilex laevigata
WINTERBERRY
Deciduous, upright shrub to 5 or 6 ft. Leaves bright green, berries orange red retained into early winter. Leaves turn yellow in fall. (Zone 4). Sources:

Ilex pedunculosa
Evergreen shrub to 8 or 10 ft. with smooth, glossy leaves. Berries bright red on pendulous stalks. (Zone 6 to part Zone 5). Sources: 47, MDTN.

Ilex pernyi
Compact evergreen shrub to 10 ft. Leaves quadrangular, glossy green, spiny. Berries red in clusters. (Zone 6). Sources: 15, 29, 30, 38, 63, MDTN.

Ilex pernyi veitchi
Leaves larger, broader and with more spines. Sources: 12, 15, 23, 63, 105, 109.

Ilex serrata
JAPANESE WINTERBERRY
Deciduous shrub to 6 or 8 ft. Berries red, retained into midwinter. (Zone 5 to part Zone 4). Sources: 113, MDTN, OHH.

Ilex verticillata
BLACK ALDER
Deciduous shrub to 8 or 10 ft. Berries glossy orange-red, long retained. (Zone 3). Sources: 1, 15, 22, 23, 32, 36, 47, 61, 62, 63, 66, 71, 81, 96, 109, 112, 114, OHH.

Ilex vomitoria
YAUPON
Evergreen shrub to 12 ft. or small tree. Berries red in clusters. (Zone 7). Sources: 15, 23, 32, 38, 42, 45, 53, 66.

Ilex vomitoria nana
Compact shrub to 4 or 5 ft. (Zone 7). Sources: 23.

Leucothoe

Leucothoe catesbaei
Evergreen shrub to 4 ft. with arching, reddish branches and rather large, glossy green leaves. Flowers hidden by the leaves. (Zone 5 to part Zone 4). Sources: 1, 6, 22, 28, 31, 36, 37, 43, 47, 57, 61, 63, 65, 66, 79, 81, 88, 91, 109, OHH.

Leucothoe catesbaei 'Rainbow'
Leaves variegated. Sources: 20, 43, MDTN.

Privet

Ligustrum acuminatum macrocarpum
Bigberry Privet
Deciduous, upright shrub to 6 or 8 ft. Berries glossy black, showy. (Zone 5). Sources:

Ligustrum amurense
Amur Privet
Deciduous, pyramidal shrub to 10 ft. or more with glossy, dark green leaves. Useful for hedges. (Zone 4 to part Zone 3). Sources: OHH, PAFA.

Ligustrum ibolium (ovalifolium x obtusifolium)
Deciduous, upright shrub to 6 or 8 ft. with glossy dark green leaves. Useful for hedges. (Zone 5). Sources: OHH.

Ligustrum japonicum
Japanese Privet
Handsome evergreen shrub to 8 or 10 ft. with dark red margined, dark green leaves. (Zone 7). Sources: 42, 63, 66.

Ligustrum lucidum
Glossy Privet
Handsome evergreen shrub to 12 ft. or small tree with large, glossy dark green leaves. (Zone 7 to part Zone 6). Sources: 12, 23, 32, 38, 42, 45, 53, 66, 109, 112, MDTN.
Varieties of **L. lucidum**
Sources: MDTN.

Ligustrum obtusifolium
Graceful shrub to 6 or 8 ft. with arching branches. Flowers white in nodding panicles, July. Quite showy. (Zone 4 to part Zone 3). Sources: OHH.

Ligustrum obtusifolium regelianum
Regel's Privet
Deciduous shrub to 5 or 6 ft. with horizontally spreading branches. (Zone 7). Sources: OHH.

Ligustrum ovalifolium
California Privet
Upright, half-evergreen shrub to 10 or 12 ft. with glossy leaves. Useful for hedges. (Zone 6 to part Zone 5). Sources: 47, OHH.

Ligustrum ovalifolium aureo-marginatum
Leaves with broad yellow margins. (Zone 6). Sources: 12, MDTN.

Ligustrum sinense
Chinese Privet
Half-evergreen shrub to 10 or 12 ft. or small tree with spreading branches. Flowers white in large, showy panicles. July. (Zone 7 to part Zone 6). Sources: 46, 53, 112.

Ligustrum vulgare
European Privet
Deciduous shrub to 10 ft. or more. Useful for hedges. (Zone 5 to part Zone 4). Sources: 47, 50, IOS, OHH.

Ligustrum vulgare aureum (vicaryi)
Deciduous shrub to 4 or 5 ft. with golden yellow leaves. (Zone 5). Sources: 14, 43, 49, 60, 70, 94, 96, 113, MDTN.

Ligustrum vulgare nanum (lodense)
Compact shrub to 3 or 4 ft. useful for low hedges. (Zone 4). Sources: 70, MDTN, OHH.
Other varieties of **L. vulgare**
Sources: OHH.

Spice-Bush

Lindera benzoin
Upright, deciduous shrub to 8 ft. or more. Leaves turn clear yellow in fall. Aromatic in all its parts. Flowers yellow, before the leaves. March-April. Requires a moist, sandy, acid soil. (Zone 4). Sources: OHH.

Honeysuckle

Lonicera bella (morrowi x tatarica)
Deciduous shrub to 6 or 8 ft. Berries bright red, in great abundance. The pink flowers fade to yellow and are not as handsome as in other honeysuckles. (Zone 3). Sources: 70, CMD, OHH.

Lonicera coerulea edulis
Deciduous shrub to 4 ft. with bluish-green leaves and dark blue, bloomy berries. (Zone 2). Sources: CMD.

Lonicera maacki podocarpa
Amur Honeysuckle
Deciduous shrub to 8 or 10 ft. with spreading branches. The dark green leaves retained until November. Flowers white. Fruits red, long retained. (Zone 4 to part Zone 3). Sources: OHH.

Lonicera nitida
Box Honeysuckle
Graceful, evergreen, upright shrub to 4 ft. with glossy leaves. Useful for low hedges. (Zone 7 to part Zone 6). Sources: 109, OHH.

Lonicera pileata
Privet Honeysuckle
Half-evergreen shrub to 3 ft. with glossy dark green leaves. Berries amethyst-violet. (Zone 6 to part Zone 5). Sources: 12, 63

Mahonia

Mahonia aquifolium
Oregon Grape
Evergreen shrub to 4 ft. Leaves spiny toothed, glossy dark green. Flowers bright yellow in dense upright panicles. April, May. Berries bluish-black, bloomy. (Zone 5). Sources: 47, MDTN, OHH.

Mahonia beali
Leatherleaf or Chinese Mahonia
Evergreen shrub to 8 ft. or more with stout upright branches. Leaves large, bluish-green with large, spiny teeth. Flowers lemon-yellow, fragrant, in large upright clusters. Fruits bluish-black, showy. (Zone 6). Sources: 14, 29, 63, 66, 114, MDTN.

Bayberry

Myrica californica
Californian Bayberry
Handsome evergreen shrub to 10 ft. or more with glossy, dark green leaves. Berries dark purple. (Zone 7). Sources:

Myrica cerifera
Wax-Myrtle
Evergreen shrub to 8 ft. or more. Berries silver-gray. (Zone 6 to part Zone 5). Sources: 109, OHH.

Myrica pennsylvanica
Northern Bayberry
Deciduous shrub to 6 ft. The grayish white berries conspicuous in winter. (Zone 2). Sources: 18, 22, 66, 81.

Heavenly Bamboo

Nandina domestica
Evergreen, upright shrub to 6 or 8 ft. with graceful foliage and glossy red berries in large panicles. (Zone 7 to part Zone 6). Sources: 2, 14, 32, 38, 42, 45, 50, 66, 80, 112, MDTN.

Mountain-Holly

Nemopanthus mucronatus
Deciduous shrub to 6 or 8 ft. Leaves turn red and yellow in fall. Berries red and showy. August-September. Requires moist, acid, sandy soil. (Zone 3). Sources:

Osmanthus

Osmanthus armatus
Chinese Osmanthus
Evergreen shrub to 10 ft. with narrow, spiny-toothed leaves on reddish stalks. Flowers fragrant. September-October. (Zone 7). Sources:

Osmanthus fortunei (ilicifolius x fragrans)
Evergreen shrub to 6 or 8 ft. Flowers very fragrant. July-August. (Zone 7). Sources: 23, 32, 63, 66, 112, MDTN.

Osmanthus ilicifolius (aquifolium)
Japanese Holly Osmanthus
Evergreen shrub to 10 ft. or more with spiny-pointed and spiny-toothed, glossy dark green leaves. Flowers fragrant. June-July. (Zone 6). Sources: 14, 23, 32, 63, 66, 109, MDTN.

Osmanthus ilicifolius aureo-marginatus
Leaves margined and variegated yellow. To 6 or 8 ft. Sources: 14, 63.

Osmanthus ilicifolius rotundifolius
Slow growing to 4 or 5 ft. Leaves roundish, almost unarmed. (Zone 6). Sources: 63, MDTN.

Mock-Orange

Philadelphus coronarius aureus
Golden Mock-Orange
Deciduous shrub to 5 or 6 ft. with bright yellow foliage. (Zone 4). Sources: 4, 35 43, 49, 60, 96, 114, OHH.

Photinia

Photinia serrulata
Chinese Photinia
Evergreen shrub to 10 ft. or more with large, glossy dark green leaves. Flowers white in broad panicles, May-July. Berries bright-red. October. (Zone 7). Sources: 12, 20, 23, 32, 38, 42, 50, 66, 81, 109, MDTN.

Photinia villosa
Oriental Photinia
Deciduous shrub to 10 ft. or more or small tree. Leaves turn red and yellow in fall. Berries bright red, persisting into the winter. (Zone 5 to part Zone 4). Sources: 1, 33, 36, 47, 48, 61, 81, 91, 114, MDTN, OHH.

Ninebark

Physocarpus intermedius parvifolius
Illinois Ninebark
Deciduous shrub to 4 or 5 ft. with dense, slender branches and small leaves. Excellent for hedges. (Zone 4 to part Zone 3). Sources: 70, 96, IOS.

Physocarpus opulifolius
Commmon Ninebark
Deciduous shrub to 8 ft. or more. Seedpods color red before repining. Flowers white or pinkish. June-July. (Zone 3 to part Zone 2). Sources: 60, 70, 96, IOS, OHH.

Physocarpus opulifolius luteus
Leaves bright yellow when young, bronze-yellow later. Sources: OHH.

Physocarpus opulifolius nanus
Compact to 5 ft. with smaller, dark green leaves. Sources: 4, 47, 70, OHH.

Trifoliate-Orange

Poncirus (Citrus) **trifoliata**
Ornamental Orange
Deciduous, spiny shrub to 8 ft. or more or small tree with 3-lobed bright green leaves. Flowers white, 2 inches across. April-May. Fruits orange-yellow, 2 inches across, long retained. Not edible. (Zone 6 to part Zone 5). Sources: 109, MDTN.

Prinsepia

Prinsepia sinensis
CHERRY PRINSEPIA
Deciduous shrub to 5 ft. or more with fresh green, early appearing leaves. Excellent hedge plant. Fruits small but edible. (Zone 3 to part Zone 2). Sources: CMD.

Plum, Cherry

Prunus americana 'Newport'
PURPLELEAF AMERICAN PLUM
with purplish-red leaves. Flowers white. (Zone 4). Sources: 43, 59, 62, 76, 80, IOS, OHH.

Prunus cistena (pumila x cerasifera atropurpurea)
PURPLELEAF SAND CHERRY
Deciduous shrub to 12 ft. or more with purplish-red foliage. Flowers white. (Zone 4). Sources: 48, 62, 64, OHH.

Prunus laurocerasus
CHERRY LAUREL
Evergreen shrub to 10 ft. or small tree with glossy dark green leaves. Flowers white. (Zone 7 to part Zone 6). Sources: 12, 14, 18, 23, 32, 38, 66, 80, 81, 114.

Prunus laurocerasus schipkaensis
To 5 ft. or more. (Zone 5 to part Zone 4). Sources: 23, 114.

Prunus maritima
BLACK PLUM, BEACH PLUM
Deciduous shrub to 5 or 6 ft. Flowers white, April-May. Useful for seashore planting. Fruits useful for jelly. (Zone 3). Sources: 18, 47, 81, 91, 114, OHH.
Selected type:
'Autumn.' Dense and compact. Suitable for hedges in sandy soil. Sources: 113.

Prunus spinosa purpurea
PURPLELEAF BLACKTHORN
Deciduous, spiny shrub to 8 or 10 ft. with dark purplish leaves and pink flowers. (Zone 5 to part Zone 4). Source:

Prunus virginiana 'Shubert'
PURPLELEAF CHOKE-CHERRY
Deciduous shrub to 8 ft. or more. Leaves green when young, soon turning purple. (Zone 3 to part Zone 2). Sources: CMD.

Firethorn

Pyracantha coccinea
Evergreen, spiny shrub to 10 ft., with bright red berries in clusters. (Zone 5). Sources: OHH, VAGR.

Pyracantha coccinea lalandi
More vigorous. Berries bright orange-red. Sources: 33, 47, MDTN, OHH.

Pyracantha coccinea kazan
To 5 ft. (Zone 4). Sources: MDTN.

Pyracantha crenato-serrata (yunnanensis)
YUNNAN FIRETHORN
Evergreen shrub to 8 or 10 ft. with coral-red berries, freely produced. (Zone 6). Sources: VAGR.

Buckthorn

Rhamnus cathartica
COMMON BUCKTHORN
Deciduous shrub with spine-tipped branchlets to 10 or 12 ft. Excellent hedge plant. Leaves round, fresh green, retained late in fall. (Zone 3). Sources: OHH.

Rhamnus davurica
DAHURIAN BUCKTHORN
Deciduous shrub to 12 ft. or more. Similar to *R. cathartica* but leaves larger and glossy. (Zone 3 to part Zone 2). Sources: 61, OHH.

Rhamnus frangula 'Columnar'
Upright columnar form of the Alder Buckthorn. Deciduous, 12 to 15 ft. Leaves glossy green, turning yellow in fall, berries red to black. Suitable for hedges. (Zone 3). Sources: OCN.

Rhamnus frangula asplenifolia
Deciduous, loosely branched shrub to 10 or 12 ft. Leaves narrowly linear with wavy margins. (Zone 4). Sources: OHH.

Rhamnus pallasi
Deciduous, spreading, spiny shrub to 3 or 4 ft. with handsome narrow, glossy leaves. Berries black. Suitable for foundation planting. (Zone 3 to part Zone 2). Sources: CMD.

Sumac

Rhus aromatica
FRAGRANT SUMAC
Deciduous, spreading shrub to 3 ft. Aromatically fragrant. Leaves turn orange and scarlet in fall. Flowers yellowish. March-April. (Zone 3). Sources: 1, 48, 61, 71, 76, 96, 114, OHH.

Rhus chinensis (semialata)
CHINESE SUMAC
Deciduous shrub to 15 ft. or small tree with pinnate leaves. Flowers creamy-white in broad panicles, August-September. Fruits orange-red. (Zone 5). Sources:

Rhus copallina
SHINING SUMAC
Deciduous shrub to 15 ft. or small tree with reddish branchlets. Leaves undivided, glossy, turning reddish-purple in fall. Fruits crimson, showy. (Zone 5 to part Zone 4). Sources: 48, 88, IOS, OHH.

Rhus glabra
SMOOTH SUMAC
Deciduous shrub to 8 or 10 ft. Leaves turn bright red in fall. Fruits scarlet. (Zone 3). Sources: VAGR.

Rhus typhina
STAGHORN SUMAC
Deciduous shrub to 10 or 12 ft. or more. Leaves turn orange and scarlet in fall. (Zone 3 to part Zone 2). Sources: 12, 88, IOS, OHH.

Rhus typhina laciniata
CUTLEAF SUMAC
Leaves laciniated. (Zone 3). Sources: OHH.

Currant

Ribes alpinum
ALPINE CURRANT
Deciduous, densely branched shrub to 6 ft. Excellent hedge plant. (Zone 3 to part Zone 2). Sources: 35, 49, 96, 113, IOS, OHH.

Ribes alpinum pumilum
Compact to 3 ft. with smaller leaves. Sources:

Ribes diacanthum
SIBERIAN CURRANT
Deciduous shrub to 5 ft. Similar to *R. alpinum* but more upright and with prickly branches and glossy leaves. Good hedge plant. (Zone 2). Sources: CMD.

Ribes fasciculatum
WINTERBERRY CURRANT
Deciduous shrub to 4 ft. Dark green until late fall. Berries scarlet, remaining all winter. (Zone 4). Sources: OHH.

Rose

Rosa rubrifolia
Graceful deciduous shrub to 5 ft. with purplish branches and purplish-blue leaves. The red flowers are not conspicuous. (Zone 3). Sources: OHH.

Willow

Salix elaeagnos (incana)
ROSEMARY WILLOW
Deciduous shrub to 15 ft. or small tree. Leaves linear, dark green above, white beneath. (Zone 4). Sources: OHH.

Salix irrorata
BLUESTEM WILLOW
Upright deciduous shrub to 9 ft. Branches silvery-blue, bloomy. Leaves glossy fresh green. (Zone 4). Sources:

Salix lucida
SHINING WILLOW
Deciduous shrub to 10 ft. or more. Branches glossy brown. Leaves glossy green on both sides. (Zone 4 to part Zone 3). Sources: OHH.

Salix purpurea
PURPLE OSIER
Graceful deciduous shrub to 10 ft. with purplish young branches. Leaves bluish beneath. (Zone 4 to part Zone 3). Sources: 18, 96, OHH.

Salix purpurea gracilis (uralensis)
To 6 or 8 ft. with narrower leaves. (Zone 3). Sources: CMD.

Salix purpurea nana
Compact to 4 or 5 ft. with bluish-gray leaves. Excellent for low hedges. (Zone 3). Sources: 1, 81, 85, 113, 114, IOS, OHH.

Elder

Sambucus canadensis maxima
AMERICAN ELDER
Deciduous shrub to 10 ft. Flower trusses larger than type. Berries purple-black. (Zone 4). Sources: OHH.

Sambucus coerulea
BLUEBERRY ELDER
Deciduous shrub to 15 ft. or more. Berries silvery-blue, very conspicuous. (Zone 5 to part Zone 4). Sources:

Sambucus nigra aurea
GOLDEN EUROPEAN ELDER
Deciduous shrub to 8 or 10 ft. Leaves golden-yellow. (Zone 5 to part Zone 4). Sources:

Sambucus pubens
AMERICAN RED ELDER
Deciduous shrub to 8 ft. with glossy, scarlet berries in June-July. (Zone 3 to part Zone 2). Sources:

Sambucus racemosa
EUROPEAN RED ELDER
Similar to *S. pubens* but less hardy. To 10 ft. Berries scarlet in June-July. (Zone 4). Sources:

Sarcococca

Sarcococca hookeriana
HIMALAYAN SARCOCOCCA
Evergreen shrub to 4 or 5 ft. with narrow, fresh green leaves. Berries black. (Zone 6). Sources: 50, 62, 63, 102, 109, MDTN.

Sarcococca ruscifolia
FRAGRANT SARCOCOCCA
Evergreen shrub to 4 or 5 ft. Leaves roundish, glossy dark green. Flowers white, not very showy but fragrant. September-February. (Zone 7). Sources: 12, 14, 50, 63, 86, 102, MDTN.

Buffalo-Berry

Shepherdia argentea
Deciduous shrub to 8 or 10 ft. or more. Branches silvery when young. Leaves silvery on both sides. Berries scarlet, edible. Useful for hedges. (Zone 3 to part Zone 2). Sources: OHH.

Mountain-Ash

Sorbus koehneana
SHRUBBY CHINESE MOUNTAIN-ASH
Deciduous shrub to 6 or 7 ft. with fine, fern-like leaves, turning dark red in fall. Berries milky white on red stalks. August-September. (Zone 4). Sources:

Stephanandra

Stephanandra incisa
Graceful, deciduous, spreading shrub to 3 or 5 ft. with finely divided, bright green leaves turning reddish purple in fall. (Zone 4). Sources: 113, OHH.

Stranvaesia

Stranvaesia davidiana
Evergreen shrub to 8 or 10 ft. or more with 4- to 5-inch-long fresh green leaves. Berries orange or scarlet in clusters. October-November. (Zone 6). Sources 47, MDTN.

Snowberry

Symphoricarpos albus (racemosus) **laevigatus**
Deciduous shrub to 5 or 6 ft. with snow white berries in terminal spikes. (Zone 3). Sources: 51.
Selected types:
'Magic Berry.' Sources: 113, MDTN.
'Mother of Pearl.' Sources: MDTN.
'White Hedge.' Sources: 113.

Symphoricarpos chenaulti
CHENAULT'S CORALBERRY
Deciduous shrub to 5 ft. Berries in terminal clusters, red with pale dots or whitish with red dots. (Zone 5). Sources: MDTN, OHH.

Symphoricarpos occidentalis
WOLFBERRY
Deciduous shrub to 3 or 4 ft. with bluish-gray leaves. Berries snow white. (Zone 3). Sources: OHH.

Symphoricarpos orbiculatus (vulgaris)
INDIAN CURRANT
Upright deciduous shrub to 5 ft. Berries purplish-red in clusters all along the slender branches. (Zone 3). Sources: 1, 7, 36, 37, 48, 71, 96, IOS, OHH.

Symphoricarpos orbiculatus leucocarpus
Berries cream-white. Sources: OHH.

Sweetleaf

Symplocos paniculata
ASIATIC SWEETLEAF
Deciduous shrub to 15 ft. or small tree with bright green, 3-inch long leaves. Flowers in panicles, white, fragrant. May-June. Berries bright blue. September. (Zone 5). Sources: 2, 36, 54, 63, 81, 109, OHH.

Blueberry

Vaccinium corymbosum
HIGHBUSH BLUEBERRY
Deciduous shrub to 8 ft. Often planted for its delicious berries but handsome in flower. May. Leaves turn orange and scarlet in fall. (Zone 4 to part Zone 3). Sources: 18, 47, 54, 61, 88, 91, 114, OHH.

Viburnum

Viburnum acerifolium
MAPLELEAF VIBURNUM
Deciduous shrub to 4 or 5 ft. Leaves turn crimson in fall. Berries black. Thrives best in shade. (Zone 3). Sources: OHH.

Viburnum betulifolium
BIRCHLEAF VIBURNUM
Deciduous shrub to 8 or 10 ft. with handsome foliage coloring brightly in fall. Berries glossy red, very conspicuous. (Zone 5). Sources: 47.

Viburnum davidi
Evergreen compact shrub to 3 or 4 ft. with 5-inch long dark green leaves. Berries blue, in clusters, conspicuous. (Zone 7). Sources: 102.

Viburnum dentatum
ARROW-WOOD
Upright, bushy deciduous shrub to 10 ft. or more with hound, coarsely-toothed leaves. Flowers white. May-June. Berries dark blue, conspicuous. (Zone 3 to part Zone 2). Sources: 1, 4, 18, 22, 32, 36, 47, 63, 76, 81, 96, 101, 114, OHH.

Viburnum ichangense
ICHANG VIBURNUM
Deciduous shrub to 5 ft. Berries bright, glossy red in clusters all along the branches. (Zone 6). Sources: MDTN.

Viburnum japonicum
JAPANESE VIBURNUM
Evergreen shrub to 5 or 6 ft. with rather large, glossy dark green leaves. Flowers fragrant, June. Berries red, October. (Zone 7). Sources: 23.

Viburnum lantana
WAYFARING TREE
Deciduous shrub to 10 or 12 ft. Leaves large, wrinkled above, dark green turning red in fall. Berries change from red to black. (Zone 4 to part Zone 3). Sources: 4, 63, 70, 76, OHH.

Viburnum lentago
NANNY-BERRY
Deciduous shrub to 10 ft. or more. Leaves color brightly in fall. Berries change from red to blue-black. (Zone 3 to part Zone 2). Sources: 47, OHH.

Viburnum opulus compactum
Compact deciduous shrub to 5 ft. or more. Red berries freely produced. (Zone 3). Sources: 113.

iburnum opulus nanum
ense compact to 3 ft., does not flower. seful for low hedges. Sources: 1, 7, 14,), 67, 70, 102, 113, 114, IOS, OHH.

iburnum prunifolium
LACK-HAW
eciduous shrub to 10 or 12 ft. The glossy een leaves color brightly in fall. Berries irk blue, bloomy, conspicuous. (Zone 4). ources: 36, 47, 70, 81, 91, 114, OHH.

iburnum setigerum (theiferum)
EA VIBURNUM
pright deciduous shrub to 10 ft. The large, irk green leaves turn bright red in fall. erries glossy red, freely produced, very owy. (Zone 5). Sources: 47, 113, MDTN, HH.

iburnum setigerum aurantiacum
erries glossy orange. Very handsome. ources: MDTN.

iburnum trilobum
MERICAN HIGHBUSH CRANBERRY
eciduous shrub to 10 ft. or more. Berries ossy scarlet in drooping clusters. Leaves rn orange and red in fall. (Zone 3 to part one 2). Sources: 4, 22, 36, 49, 61, 62, 70,), 101, OHH.

Viburnum wrighti
Deciduous shrub to 7 or 8 ft. The round leaves turn crimson in fall. Berries bright red, showy. (Zone 5). Sources: 47, 113, MDTN, OHH.

Weigela

Weigela florida variegata
Deciduous shrub to 4 ft. Leaves edged and variegated pale yellow. Flower pink. (Zone 4). Sources: 43, 60, 96, 114.

Yellow-Root

Xanthorhiza simplicissima (apiifolia)
Deciduous shrub to 3 ft. Leaves deeply incised. Flowers brownish-red in graceful racemes. (Zone 4). Sources: 47, OHH.

Prickly-Ash

Zanthoxylum schinifolium
Deciduous shrub to 10 ft. with prickly branches and graceful foliage. Fruits brown but rather conspicuous in fall. (Zone 5). Sources:

Zanthoxylum simulans
FLATSPINE PRICKLY ASH
Spreading deciduous shrub to 10 or 12 ft. with lustrous foliage and red fruits. (Zone 5). Sources:

Sapphire-blue fruits of *Symplocos paniculata* Bu

FLOWERING TREES

Horse-Chestnut

Aesculus carnea
RED HORSE-CHESTNUT
Round-headed tree to 40 or 45 ft. Flowers flesh-colored to deep red. May-June. (Zone 4). Sources: 66, 114, OHH.

Aesculus carnea brioti
SCARLET HORSE-CHESTNUT
Flowers bright scarlet. May-June. (Zone 4). Sources: 14, 86, 114.

Aesculus hippocastanum
COMMON HORSE-CHESTNUT
Stately tree to 60 ft. or more. Flowers white, tinged reddish. May-June. (Zone 3). Sources: 62, 86, OHH.

Aesculus hippocastanum baumanni
BAUMANN'S HORSE-CHESTNUT
Flowers double, white. May-June. *Does not set fruits.* (Zone 4 to part Zone 3). Sources: 86, OHH.
For **Aesculus glabra** and **octandra**, see Shade Trees; **Aesculus parviflora**, see Flowering Shrubs.

Silk-Tree

Albizzia julibrissin
SILK-TREE
Tree to 25 ft. or more. Shrubby in Zone 6. Flowers light pink in slender-stalked heads, June-August. (Zone 7). Sources: generally available.
Selected types: **'Charlotte'** and **'Tryon.'** Sources: MDTN.

Albizzia julibrissin rosea
Usually more or less shrubby in Zone 5, to 15 ft. or more. June-August. Flowers bright pink. (Zone 6 to part Zone 5). Sources: 14, 47, 62, 63, 81, 114, OHH.

Albizza julibrissin rubra
Flowers deep pink. June-August, (Zone 6). Sources: 32.

Shadbush, Service-Berry

Amelanchier canadensis
Tree to 40 ft. or more. Flowers white. May. Fruits deep purple. (Zone 3 or 4). Sources: 12, 28, 36, 54, 62, 63, 81, 91, 112, 114, OHH.

Amelanchier grandiflora
APPLE SERVICE-BERRY
Tree to 30 ft. or tall shrub. Flowers white, rather large. May. (Zone 4). Sources: 63, OHH.

Amelanchier grandiflora rubescens
Usually a tall shrub. Flowers purplish i bud, soft pink when open. May. (Zone 4 Sources: OHH.

Amelanchier laevis
ALLEGHANY SERVICE-BERRY
Tree to 30 ft., sometimes shrubby. Your leaves reddish-bronze. Flowers white drooping racemes. May. Fruits sweet. (Zo 3). Sources: 22, 48, 53, 61, 114.
Amelanchier asiatica, see Flowerin Shrubs

Catalpa

Catalpa bignonioides
INDIAN-BEAN
Tree to 30 ft. Flowers white, striped yello and spotted purple. June-July. (Zone 4 Sources: 114.

Catalpa bignonioides nana
UMBRELLA-CATALPA
Usually grafted high to form a rou crown. Does not flower when trimme (Zone 4). Sources: 53, 106, 112, 114.

Catalpa ovata
JAPANESE CATALPA
Tree to 25 ft. or more. Flowers crea colored, striped orange, spotted violet. Ma (Zone 4). Sources: OHH.

Catalpa speciosa
WESTERN CATALPA
Tree to 60 ft. or more. Hardier than t others. Flowers whitish with two yell stripes inside. June. (Zone 4 to part Zo 3). Sources: 50, 101, 112, 114, OHH.

Redbud, Judas-Tree

Cercis canadensis
Tree to 25 ft. or tall shrub. Flowers ros pink. April-May. (Zone 4). Sources: ge erally available.

Cercis canadensis alba
WHITE-FLOWERED REDBUD
Flowers white. (Zone 4). Sources: 14, 23, 48, 62, 63, 109, OHH.

Cercis canadensis rosea
'Wither's Pink Charm'
Flowers light pink. (Zone 4). Source 20, 63, 113.

Cercis chinensis
CHINESE REDBUD
Tree to 25 ft. or tall shrub. Flowers ros purple. May. (Zone 5). Sources: 14, 36, 38, 42, 60, 62, 63, 81, 113, 114, OH

Yellow-Wood

ladrastis lutea
ree to 30 ft. or more. Flowers white, ragrant, in drooping panicles. June. Zone 3). Sources: 22, 48, 62, 63, 66, 81, 4, OHH.

Dogwood

ornus florida
LOWERING DOGWOOD
mall tree to 15 or 25 ft. Flower bracts hite, May. Berries red, Sept.-Oct. (Zone to 4). Sources: Commonly available.

ornus florida 'White Cloud'
ery free-flowering selection. Sources: 113.

ornus florida pluribracteata (flore plena)
OUBLE WHITE FLOWERING DOGWOOD
ources: 6, 14, 16, 20, 28, 37, 43, 47, 62, 3, OHH.

ornus florida pendula
EEPING WHITE FLOWERING DOGWOOD
ources: 14, 47, 63, 66, 114.

ornus florida rubra
ED FLOWERING DOGWOOD
ources: 22, NJPR, OHH, WBC.

ornus florida welchi
ARIEGATED FLOWERING DOGWOOD
ources: 14, 43, 114, OHH.

ornus kousa
APANESE FLOWERING DOGWOOD
ree to 15 ft. Flower bracts white, June. ruits strawberry-like, red, August. (Zone). Sources: 6, 7, 18, 22, 28, 47, 54, 62, 63, 1, 91, 114, OHH.

ornus kousa chinensis
HINESE FLOWERING DOGWOOD
omewhat hardier. Sources: 14, 43, 61, 2, 63, 113, 114, OHH, WBC.

ornus nuttalli
ACIFIC FLOWERING DOGWOOD
ree to 30 ft. or more. Succeeds best on ie West Coast. Flower bracts white, often nged pink. (Zone 7 or 6). Sources: 12, 4, 88.

'or other Cornus, see Shrubs for Foliage nd Fruits.

Hawthorn

rataegus arnoldiana
RNOLD HAWTHORN
'ree to 15 ft. Flowers white and rather irge. May. Fruits orange-red, very conpicuous but dropping early. (Zone 4 to art Zone 3). Sources: 61, OHH.

rataegus coccinioides
'ree to 15 ft. Flowers white, May. Fruits ark crimson. Leaves color brightly in fall. Zone 5 to 4). Sources: OHH.

rataegus crus-galli
OCKSPUR HAWTHORN
'ree to 25 ft. or large shrub. Flowers hite. May-June. Leaves color brightly in all. Fruits bright red. October-February. Zone 4). Sources: 47, CSN, OHH.

Crataegus lavallei
LAVALLE'S HAWTHORN
Tree to 15 ft. Leaves color brightly in fall. Flowers white. May. Fruits scarlet, remaining through most of the winter. (Zone 4). Sources: 47, 81, CSN, OHH.

Crataegus monogyna stricta
Fastigiate tree to 15 ft. with erect branches. No fall color. Flowers white. May. Fruits red. (Zone 4 to 3). Sources: CSN, OHH.

Crataegus nitida
Round-headed tree to 20 ft. or more. Flowers white. Fruits red, remaining through the winter. Leaves lustrous, changing to orange and scarlet in fall. (Zone 4 to 3). Sources: OHH.

Crataegus oxyacantha
ENGLISH HAWTHORN
Tree to 25 ft. Without fall color. Flowers white. Fruits scarlet. (Zone 4 to part Zone 3). Sources: 61, 62, 91, 113, OHH.

Crataegus oxyacantha punicea
Flowers single, dark red. (Zone 4 to 3). Sources: OHH.

Crataegus oxyacantha pauli (coccinea plena)
PAUL'S DOUBLE SCARLET HAWTHORN
Flowers double, bright scarlet. (Zone 4). Sources: 76, OHH.

Crataegus oxyacantha plena
Flowers double, white. (Zone 4 to 3). Sources: OHH.

Crataegus oxyacantha rosea plena
Flowers double, pink. (Zone 4). Sources: 22, 81, 114, OHH.

Crataegus persistens
Low tree to 10 ft. Flowers white, May. Fruits crimson, remaining through most of winter. Leaves lustrous, stay green into early winter. (Zone 5). Sources: OHH.

Crataegus phaenopyrum (cordata)
WASHINTON HAWTHORN
Tree to 25 ft. Leaves changing to scarlet and orange in fall. Flowers white. May-June. Fruits scarlet in large clusters. (Zone 4). Sources: Commonly available.

Crataegus pinnatifida major
Tree to 15 ft. With lustrous, dark green, deeply lobed leaves. Fruits 1 inch across, lustrous deep red. Edible. (Zone 5). Sources: OHH.

Crataegus succulenta
FLESHY HAWTHORN
Tree to 12 ft. Flowers white, rather large, in many-flowered corymbs. May. Fruits bright red, September-October. (Zone 3). Sources: OHH.

For other Hawthorns, see Shrubs for Foliage and Fruits

Dove-Tree

Davidia involucrata
Tree to 40 ft. or more with rather large leaves. Flowers with creamy-white, to 6-inch-long bracts. May-June. (Zone 6 to 5). Sources: 14, 34, 63, 109, 113.

Ash

Fraxinus ornus
Round-headed tree to 35 or 40 ft. Flowers white and showy, fragrant, in dense panicles. May-June. (Zone 5). Sources: 14, 43, 62.

Silver-Bell

Halesia carolina (tetraptera)
Carolina Silver-Bell
Tree to 20 ft. or large shrub. Leaves turn yellow in fall. Flowers white, bell-shaped. April-May. (Zone 4). Sources: 1, 47, 63, 66, 71, 114, OHH.

Halesia monticola
Mountain Silver-Bell
Tree to 50 or 60 ft. Leaves turn yellow in fall. Flowers white, bell-shaped. May. (Zone 5). Sources: 7, 18, 61, 62, 63, 70, 113.

Goldenrain Tree

Koelreuteria paniculata
Tree to 20 ft. or more with pinnate leaves. Flowers bright yellow in loose panicles. July-August. (Zone 4). Sources: 91, NJPR, OHH, WBC.

Golden Chain Tree

Laburnum alpinum
Scotch Laburnum
Tree to 20 ft. or tall shrub. Flowers golden yellow in drooping racemes, to 16 inches. June. (Zone 4). Sources: OHH.

Laburnum watereri (vossi)
Golden Chain Tree
Tree to 15 ft. or tall shrub. Superior to *L. anagyroides*. Racemes of flowers longer and flowers larger than in *L. alpinum*. (Zone 5 to part Zone 4). Sources: 91, 113, OHH, WBC.

Magnolia

Magnolia denudata
Yulan Magnolia
Tree with spreading branches to 35 ft. Flower white, fragrant, to 6 inches across. April-May. Sources: OHH.

Magnolia kobus
Tree to 20 ft. Usually shrubby in cultivation. Flowers white, to 4 inches across. April-May. (Zone 5 to 4). Sources: 109, OHH.

Magnolia kobus borealis
Pyramidal tree to 50 ft. or more. Not flowering when young. Flowers creamy white, almost 5 inches across. April-May. (Zone 4). Sources: OHH.

Magnolia salicifolia
Anise Magnolia
Slender tree to 20 or 25 ft. Leaves bluish underneath. Flowers white to greenish white, purple at base, almost 5 inches across April-May. (Zone 5). Sources: OHH.

Magnolia sieboldi
Oyama Magnolia
Tree to 20 or 25 ft. Leaves bluish underneath. Flowers cup-shaped, white, fragrant 3-4 inches across. June-July. (Zone 6 to part Zone 5). Sources: 109, OHH.

Magnolia soulangeana
Saucer Magnolia
Tree to 15 ft. or large shrub. Flowers large upright, bell-shaped, more or less purplish not fragrant. (Zone 4 to part Zone 3) Sources: 47, 91, NJPR, OHH.

Magnolia soulangeana alexandrina
Flowers white, tinged purple toward the base. Sources: 43, 63, 70, 113, 114.

Magnolia soulangeana lennei
Flowers rose-purple outside, white inside Sources: 14, 36, 43, 63, 70, 86, 91, 114 OHH.

Magnolia soulangeana nigra
Flowers dark purple outside. Sources: 7 12, 14, 29, 43, 112, 113.
Other named varieties Sources: MDTN.

For other Magnolias, see Flowering Shrub

Crab-Apple

Malus arnoldiana
Arnold Crab-Apple
Tree to 25 ft. Fruits small, yellow. Flowers pink, changing to white, 1½ inch across May. (Zone 4 to part Zone 3). Sources 6, 17, 47, 66, 70, 74, 91, 114, OHH.

Malus atrosanguinea
Carmine Crab-Apple
Usually shrubby to 15 ft. Fruits small red. Flowers rose-purple in bud, pink when open. (Zone 4). Sources: 22, 47, OHH.

Malus baccata
Siberian Crab-Apple
Tree to 30 ft. Flowers white, 1½ inch across. Fruits small, red or yellow. (Zone 2). Sources: 22, 47, 70, 114, OHH.

Malus baccata mandshurica
Mandshurian Crab-Apple
Tree to 30 ft. or more. Flowers white fragrant. Fruits larger. (Zone 3). Sources 113, OHH.

Malus coronaria charlottae
Charlotte's Crab-Apple
Tree to 20 ft. Fruits greenish, not showy and not freely produced. Flowers semi-double, light pink. (Zone 4). Sources: 7 86, 110, 114, OHH.

Malus floribunda
JAPANESE FLOWERING CRAB-APPLE
Tree to 25 ft. Usually a tall shrub. Fruits small, red. Flowers carmine in bud, pale pink to nearly white when open. (Zone 4 to part Zone 3). Sources: 47, NJPR, OHH.

Malus halliana parkmani
PARKMAN'S CRAB-APPLE
Tree to 10 ft. or tall shrub. Fruits small purplish-red. Flowers rose-pink, semidouble. (Zone 5). Sources: 2, 6, 32, 47, 54, 63, 76, 114, OHH.

Malus hillieri
HILLIER'S CRAB-APPLE
Tree to 25 ft. Flowers almost 1 inch across, semidouble. Crimson in bud, bright pink when open. (Zone 4). Sources: 113.

Malus hupehensis (theifera)
TEA CRAB-APPLE
Tree to 15 ft. Fruits yellow with red cheeks. Flowers white or pinkish, fragrant. Handsome in fruit. (Zone 4). Sources: 22, 6, 47, 61, 63, 86, 91, 114, OHH.

Malus hupehensis rosea
Flowers clear pink. Sources: OHH.

Malus ioensis plena
BECHTEL'S CRAB-APPLE
Tree to 25 ft. Does not fruit. Flowers large, fully double, soft pink. (Zone 3 to part Zone 2). Sources: 12, 17, 28, 32, 36, 54, 4, 76, 79, 113, 114, OHH.

Malus micromalus
KAIDO CRAB-APPLE
Small, upright tree to 15 ft. Fruits ½ inch across, red. Flowers bright pink, 1½ inch across, fragrant, freely produced. (Zone 4). Sources: 113.

Malus purpurea
PURPLE CRAB-APPLE
Tree to 15 or 25 ft. or tall shrub with purple branches and purple young leaves. Flowers purplish-pink. Fruits dark red, 1 inch across. (Zone 4 to part Zone 3). Sources: 63, 114, OHH.

Malus purpurea aldenhamensis
Usually a tall shrub. Leaves purplish, fruit dark red. Flowers semidouble, 1 inch across, wine-purple. (Zone 4). Sources: 49, 74, OHH.

Malus purpurea eleyi
ELEY'S CRAB-APPLE
Tree to 20 ft. or more. Leaves purplish. Fruits deep red, 1 inch across. Flowers freely produced, single, deep pink. (Zone 4 to part Zone 3). Sources: 38, 47, 60, 70, 74, 109, 114, OHH, PAFA.

Malus spectabilis riversi
RIVERS' CRAB-APPLE
Tree to 15 ft. Fruits yellowish, rarely produced. Flowers 2 inches across, double pink. (Zone 4). Sources: 14, 36, 63, 91, OHH.

Malus toringoides
CUTLEAF CRAB-APPLE
Tree to 15 ft. or tall shrub. Very handsome in fruit. Flowers white to pinkish, 1 inch across. (Zone 5 to part Zone 4). Sources: 47, OHH.

Other Crab-Apples of Hybrid Origin:

'Crimson Brilliant'
Tree to 15 or 20 ft. Very floriferous. Flowers bright crimson. Fruits purplish-red, cherry-size. (Zone 4 to part Zone 3). Sources: 113.

'Dorothea'
Tree to 20 or 25 ft. Flowers double, 2 inches across, bright, deep pink. Fruits yellow. (Zone 4). Sources: 7, 22, 70, 96, 113, 114, OHH.

'Flame'
Tree to 20 ft., of pyramidal shape. Flowers single, bright pink. Fruits scarlet, freely produced. (Zone 4). Sources: 70, 74, 96, 114.

'Hopa'
Tree to 20 or 25 ft. Flowers bright pink, fruits 2 inches across, red, good for jelly. (Zone 4 to part Zone 3). Sources: 28, 43, 53, 62, 66, 70, 71, 86, 91, 113, NJPR, OHH, PAFA.

'Katherine'
Flowers rather large, pink in bud, opening white. Freely produced. (Zone 4). Sources: 26, 51, 53, 63, 66, 70, 86, 109, 113, 114, OHH.

'Liset'
Tree to 20 or 25 ft. Leaves reddish bronze. Fruits dark red. Flowers single, 1½ inch across, purplish red, freely produced. (Zone 4). Sources: 113.

'Pink Weeper'
Semi-weeping Crab-Apple. Tree to 15 or 20 ft. Flowers dark red in bud, pink when open. (Zone 4). Sources: 113.

'Red Jade' (Offspring of 'Excellenz Thiel')
Partly weeping, spreading tree. Flowers white, freely produced. Fruits small, bright red, in great abundance. (Zone 4 to part Zone 3). Sources: 60, 113.

Sour-Wood

Oxydendrum arboreum
SORREL TREE
Tree to 40 ft. or more. Leaves turn scarlet in fall. Flowers white, in 10-inch-long drooping panicles. July-August. (Zone 4). Sources: 47, OHH.

Empress Tree

Paulownia tomentosa (imperialis)
Tree to 35 ft. or more, with large leaves. Flowers 2 inches long, funnel-shaped pale violet with darker spots and with yellow stripes inside, April-May. (Zone 6 to part Zone 5). Sources: 62, 109, OHH.

Cherry, Peach, Plum

Prunus avium plena
Double-Flowered Mazzard Cherry
Tree to 45 ft. or more. Flowers fully double, white, freely produced. Does not set fruits. (Zone 4 to part Zone 3). Sources: OHH.

Prunus cerasus rhexi
Double-Flowered Sour-Cherry
Tree to 20 or 25 ft. One of the hardiest flowering cherries. Flowers fully double, white, freely produced. Does not set fruits. (Zone 3). Sources:

Prunus davidiana
David Peach
Tree to 20 or 25 ft. Flowers about 1 inch across, light pink or white. End of March-April. (Zone 4 to part Zone 3). Sources: OHH.

Prunus moseri (P. pissardi flore roseo-pleno)
Veitch's Double-Flowering, Purple-Leaf Plum
Tree to 12 or 15 ft. with purplish leaves. Flowers 1 inch across, double pink. April. Fruits 1 inch across, red, sweet. (Zone 4). Sources: 113.
For other forms of this Plum, see Trees Planted for Foliage

Prunus persica albo-plena
Double White-Flowered Peach
Tree to 12 or 15 ft. April. (Zone 4). Sources: 43, 114, OHH.
Selected type: **'Iceberg.'** Sources: 113.

Prunus persica albo-plena pendula
Weeping Double White-Flowered Peach
Sources: 113.

Prunus persica roseo-plena
Double Pink-Flowered Peach
Tree to 12 or 15 ft. April. (Zone 4). Sources: OHH.
Selected types: **'Pink Charming.'** Sources: 113, OHH.
'Clara Moyer.' Sources: OHH.

Prunus persica rubro-plena
Double Red-Flowered Peach
Tree to 12 or 15 ft. April. (Zone 4). Sources: 6, 20, 32, 38, 43, 48, 49, 53, 54, 60, 66, 69, 71, 74, 81, 101, 109, 114, OHH.
Selected type: **'Cardinal.'** Sources: 113.

Prunus persica rubro-plena pendula
Weeping Double Red-Flowered Peach
Sources: 113.

Prunus sargenti
Sargent's Japanese Cherry
Tree to 50 ft. or more. Fruits small, blackish-purple. Flowers 1½ inch across, rose-pink. April-May. (Zone 4 to part Zone 3). Sources: OHH.

Prunus serrulata
Oriental Cherry
Tree to 50 ft. or more. Fruits small, black. Flowers 2 inch across, white. April. (Zone 5 to part Zone 4). Sources: OHH.

Prunus serrulata 'Amanogawa'
Fastigiate tree. Flowers semidouble, pale pink. (Zone 5). Sources: 6, 20, 40, 47, 61, 71, 91, 113, 114, OHH.

Prunus serrulata 'Fugenzo' ('James H. Veitch')
Flowers double, rose-pink. Very pretty. (Zone 5 to part Zone 4). Sources: 6, 47, 63, 113, OHH.

Prunus serrulata 'Kiku-Shidare'
Tree with spreading or pendant branches. Flowers very double, pink. (Zone 5 to part Zone 4). Sources: 63, 113.

Prunus serrulata 'Sekiyama' ('Kwanzan')
Flowers large, double, rose-red. April-May. (Zone 5 to part Zone 4). Sources: 47, 49, 113, NJPR.

Prunus serrulata 'Shirofugen' ('Victory')
Flowers double, pink in bud, changing to white. April. (Zone 5 to part Zone 4). Sources: 113, OHH.

Prunus serrulata 'Shirotae'
Flowers double or semidouble, white. April. (Zone 5). Sources: 17, 47, 49, 63, 66, 71, 91, 113, 114, OHH.

Prunus sieboldi (pseudocerasus)
Naden Cherry
Tree to 15 ft. Flowers over 1 inch across, light pink. April. (Zone 5 to part Zone 4). Sources: 48, 53, 69, 104, 109, OHH.
Other named varieties of Flowering Oriental Cherries: 113, OHH.

Prunus subhirtella
Higan Cherry
Slender branched tree to 20 ft. or more. Fruits very small, blackish. Flowers 1 inch across, pale pink, freely produced April. (Zone 5 to part Zone 4). Sources: NJPR, OHH.

Prunus subhirtella ascendens
Tree to 35 ft. or more. Flowers pale pink. April. (Zone 5). Sources: 63, OHH.

Prunus subhirtella autumnalis
Tree to 12 ft. or tall shrub. Flowers semi-double, pale pink, produced in spring and in fall. (Zone 4 to part Zone 3). Sources: 49, 113, 114, OHH.

Prunus subhirtella pendula
Weeping Higan Cherry
Tree with slender, pendulous branches. Flowers light pink. April. (Zone 4). Sources: 47, 49, 69, 113, NJPR, OHH.

Prunus subhirtella pendula 'Yae-Shidare' (pendula flore plena)
Weeping Double-Flowered Higan Cherry
Weeping tree with double pink flowers. April. (Zone 5 to part Zone 4). Sources: 1, 7, 12, 17, 48.

Prunus yedoensis
YOSHINO CHERRY
Tree to 35 ft. or more. Flowers 1½ inch across, white or pinkish. April. (Zone 5 to part Zone 4). Sources: 47, 48, 69, 89, OHH.

Prunus yedoensis 'Taizanfukun'
Flowers double, pink. April. (Zone 5). Sources: OHH.

Epaulette Tree

Pterostyrax corymbosa
LITTLE EPAULETTE TREE
Tree to 15 ft. or tall shrub. Flowers white in 5-inch long drooping panicles. June. (Zone 6). Sources: OHH.

Pterostyrax hispida
Tree to 35 ft. with slender, spreading branches. Flowers creamy-white, fragrant in 10-inch-long pendulous panicles. June. (Zone to part Zone 4). Sources:

Locust

Robinia pseudoacacia
BLACK LOCUST
Tree to 50 ft. or more. (Subject to attack by borers.) Flowers white, very fragrant. June. (Zone 3). Sources: 33, 47, 66, 101, 114, OHH.

Robinia pseudoacacia decaisneana
PINK-FLOWERED BLACK LOCUST
Tree to 30 ft. or more. Flowers rose-pink, freely produced. June. (Zone 4 to part Zone 3). Sources: 17, 47, 86, OHH.

Robinia 'Monument' (variety or hybrid of R. hispida)
UPRIGHT ROSE ACACIA
Tree of 10 to 12 ft. Flowers deep rose-pink. May- June. (Zone 4). Sources: 113.

For other Robinias, see Shade Trees and Flowering Shrubs

Pagoda-Tree, Scholar-Tree

Sophora japonica
JAPANESE PAGODA-TREE
Tree to 40 or 50 ft. The shiny leaves remain dark green until late fall. Flowers yellowish-white in loose erect panicles. August-September. (Zone 4). Sources: 32, 43, 47, 48, 62, 63, 66, 70, 71, 114, OHH, WBC.

Stewartia

Stewartia koreana
KOREAN STEWARTIA
Tree to 35 ft. Leaves turn orange in fall. Flowers to 3 inches across, white, showy. June-July. (Zone 5). Sources: 62, 109.

Stewartia pseudocamellia
JAPANESE STEWARTIA
Tree to 45 ft. or tall shrub. Leaves turn dark purple in fall. Flowers cup-shaped, 2½ inches across, white. July-August. (Zone 5). Sources: 14, 28, 47, 62, 63, 109.

For other Stewartias, see Flowering Shrubs

Snowbell, Storax

Styrax japonica
JAPANESE SNOWBELL
Tree to 20 ft. Usually a tall shrub. Flowers white, pendulous on slender stalks. June-July. (Zone 5 to part Zone 4). Sources. 14, 28, 47, 63, 66, 102, 109, 114, OHH.

Styrax obassia
FRAGRANT SNOWBELL
Tree to 20 ft. or tall shrub with rather large, round leaves. Flowers almost 1 inch across, white in drooping racemes. May-June. (Zone 5 to part Zone 4). Sources: 47, OHH.

Lilac

Syringa amurensis japonica
JAPANESE TREE LILAC
Tree to 25 ft. With dark green heart-shaped leaves. Flowers white in loose, upright panicles (not lilac-scented). June. (Zone 3). Sources: 33, 47, 56, 61, 63, 70, 71, 91, 110, OHH.

Roche

Shadbush (*Amelanchier canadensis*) has delicate white flowers in early spring

DECIDUOUS TREES PLANTED FOR FOLIAGE

Those useful as shade trees marked "" (See also Flowering Trees)*

Conifers That Lose Leaves In Winter

Larch

Larix decidua (europaea)
EUROPEAN LARCH
Broadly pyramidal tree to 75 ft. with drooping secondary branchlets. (Zone 3 to part Zone 2). Sources: 14, 43, 70, 71, 114, OHH.

Larix leptolepis
JAPANESE LARCH
Handsome fast growing tree to 60 ft. with horizontal branches. (Zone 4 to part Zone 3). Sources: 43, 61, 79, 81, 91, 114, OHH, PAFA.

Dawn Redwood

Metasequoia glyptostroboides
Handsome tree to 45 ft. or more with ascending branches and bright green foliage. (Zone 4 to part Zone 3). Sources: 14, 47, 60, 61, 62, 63, 109, 113, 114, MDTN.

Golden-Larch

Pseudolarix amabilis (kaempferi)
Handsome broadly pyramidal tree to 75 ft., foliage long, light green turning bright yellow in fall. (Zone 5). Sources: 14, 47, 63.

Bald Cypress

Taxodium distichum
Tree to 50 ft. with brown branches and light green foliage. (Zone 4). Sources: 14, 32, 62, 109.

Other Deciduous Trees

Maple

Acer buergerianum
TRIDENT MAPLE
Graceful small tree to 20 or 25 ft. Leaves 3-lobed. (Zone 5 to part Zone 4). Sources: NJPR, OHH.

Acer campestre
HEDGE MAPLE
Round-headed tree to 25 ft or tall shrub with small leaves. Suitable for tall hedges. (Zone 5 to part Zone 4). Sources: NJPR, OHH.

Acer cissifolium
Graceful tree to 20 ft. of distinct appearance. Leaves turn red and yellow in fall. (Zone 6 to part Zone 5). Sources: MDTN.

Acer griseum
PAPERBARK MAPLE
Handsome tree to 15 or 20 ft. Bark cinnamon brown, separating in papery flakes. (Zone 5). Sources: 14, 63.

***Acer macrophyllum**
OREGON MAPLE
Tree to 60 ft. or more with large leaves, turning orange in fall. Flowers yellow, fragrant in pendulous panicles. Rather showy. May. (Zone 7 to part Zone 6). Sources:

***Acer nikoense**
NIKKO MAPLE
Handsome and distinctive tree to 25 ft. or more. Leaves turn brilliant red or purple in fall. (Zone 6 to part Zone 5). Sources: MDTN.

Acer pennsylvanicum
MOOSEWOOD, STRIPED MAPLE
Tree to 15 or 20 ft. Branches green, striped white. Requires sandy, acid soil. (Zone 3). Sources: OHH.

***Acer platanoides**
NORWAY MAPLE
Tree to 50 ft. or more. Without conspicuous fall coloring. (Zone 4 to part Zone 3). Commonly available.

***Acer platanoides columnare**
COLUMNAR NORWAY MAPLE
Columnar tree with ascending branches to 50 ft. or more. (Zone 4 to 3). Sources: 1, 49, 61, 63, 70, 71, 76, 114, OHH.

***Acer platanoides 'Crimson King'**
RED NORWAY MAPLE
Leaves remain dark red throughout the year. Not quite as hardy as others. (Zone 5 to part Zone 4). Sources: 60, 91, 113, NJPR.

***Acer platanoides globosum**
GLOBE NORWAY MAPLE
Tree with dense, globose head to 25 ft. (Zone 4). Sources: OHH.

Acer platanoides schwedleri
SCHWEDLER NORWAY MAPLE
Tree to 50 ft. or more. Leaves bright red when young, gradually turning green. (Zone 4 to part Zone 3). Sources: OHH.

Acer platanoides variegatum (drummondi)
VARIEGATED NORWAY MAPLE
Tree to 30 ft. or more. Leaves variegated white. (Zone 4). Sources: 70, 114, NJPR

*Acer pseudoplatanus
SYCAMORE MAPLE
Broad-headed tree to 60 ft. or more. Not as hardy as the Norway maple. (Zone 5). Sources: 81, NJPR, OHH.

*Acer pseudoplatanus purpureum
Leaves purple beneath. Handsomer than the type. (Zone 5). Sources:

*Acer rubrum
RED MAPLE
Handsome tree to 60 or 80 ft. Leaves bluish beneath, color brilliant in fall. Flowers red and conspicuous, before the leaves. March-April. Requires moist, acid, sandy soil. (Zone 3). Commonly available.

*Acer rubrum columnare
COLUMNAR RED MAPLE
Of upright, columnar habit. (Zone 4). Sources: 63, OHH.

Acer saccharinum
SILVER MAPLE
Fast growing tree to 80 ft. or more. Leaves deeply lobed, silvery beneath, coloring yellow or orange in fall. Not recommended as a street tree because of its brittle branches. (Zone 3). Commonly available.

Acer saccharinum pyramidale
Narrowly pyramidal. Sources: OHH.

Acer saccharinum laciniatum (wieri)
Leaves narrowly dissected, branches pendulous. Sources: OHH.

*Acer saccharum
SUGAR MAPLE
Broad-headed tree to 75 ft. or more. Leaves color brilliantly in fall. Requires slightly acid, stony soil. (Zone 3). Sources: OHH.

*Acer saccharum monumentale
COLUMNAR SUGAR MAPLE
(Zone 4). Sources: 63.

Horse-Chestnut

Aesculus, see Flowering Trees

Alder

*Alnus cordata
ITALIAN ALDER
Round-headed tree to 30 ft. or more with shiny, heart-shaped leaves. (Zone 5). Sources:

*Alnus glutinosa
BLACK ALDER
Round-headed tree to 50 ft. or more with dark green leaves retained late in fall. Requires moist soil. (Zone 3). Sources: OHH.

Alnus glutinosa laciniata
CUTLEAF BLACK ALDER
(Zone 4). Sources:

*Alnus hirsuta
MANCHURIAN ALDER
Handsome, broadly pyramidal tree to 40 ft. Leaves bluish beneath. (Zone 4). Sources:

Alnus incana
SPECKLED ALDER
Tree to 40 or 50 ft. Leaves bluish-gray beneath. (Zone 3). Sources:

Alnus incana pendula
WEEPING ALDER
With pendulous branches. (Zone 3). Sources:

Birch

*Betula lenta
CHERRY BIRCH
Handsome pyramidal tree to 50 ft. with reddish bark. Catkins long, pendulous, conspicuous. (Zone 3). Sources: 70, 88, OHH.

*Betula maximowicziana
MONARCH BIRCH
Very handsome tree to 60 ft. with orange-gray bark and large leaves. Branches reddish-brown. (Zone 5 to part Zone 4). Sources: OHH.

Betula nigra
RIVER BIRCH
Graceful tree to 50 ft. with oval crown. Bark exfoliating in papery flakes. Requires moist, sandy soil. (Zone 4). Sources: OHH.

*Betula papyrifera
CANOE BIRCH
Handsome tree to 50 ft. or more with white, exfoliating bark. Leaves turn bright yellow in fall. (Zone 2). Sources: 62, 70, 76, 79, 81, 91, CSN, OHH.

*Betula pendula (alba)
EUROPEAN BIRCH
Graceful tree to 45 or 50 ft. with white bark. (Zone 3). Sources: 91, CSN.

Betula pendula fastigiata
PYRAMIDAL BIRCH
Columnar with upright branches. (Zone 3) Sources: CSN.

Betula pendula gracilis (laciniata)
CUTLEAF WEEPING BIRCH
Leaves finely dissected. Sources: CSN, OHH.

Betula pendula tristis (alba pendula)
With slender, pendulous branches. Sources:

Hornbeam

Carpinus betulus
EUROPEAN HORNBEAM
Tree to 40 or 50 ft. Suitable for tall hedges. No fall color. (Zone 5 to part Zone 4). Sources: 63, OHH.

Carpinus betulus columnaris
More slender than fastigiata. Sources: 113.

Carpinus betulus fastigiata
Narrowly pyramidal tree to 15 ft. or more. (Zone 5). Sources: 14, 48, 49, 63, 114, CSN, OHH.

Carpinus caroliniana
AMERICAN HORNBEAM
Bushy tree to 20 or 25 ft. Leaves turn orange or scarlet in fall. (Zone 3 to part Zone 2). Sources: 48, OHH.

*Carpinus cordata
HEARTLEAF HORNBEAM
Tree to 40 or 45 ft. with rather large, handsome foliage. (Zone 5). Sources:

Carpinus tschonoski
YEDDO HORNBEAM
Graceful bushy tree to 20 or 25 ft. with small leaves. (Zone 5). Sources: OHH.

Hickory

*Carya ovata
SHAGBARK HICKORY
Tree to 75 ft. with shaggy bark and edible nuts. (Zone 4 to part Zone 3). Sources: 99, 110, OHH.

Chestnut

Castanea mollissima
CHINESE CHESTNUT
Tree to 50 ft. Planted for the edible nuts. Resistant to blight. (Zone 5 to part Zone 4). Sources: 2, 6, 32, 48, 49, 53, 79, 99, 114, OHH.

Catalpa

Catalpa, see Flowering Trees

Hackberry

*Celtis occidentalis
Round-headed tree to 60 ft. or more. Leaves bright green turning yellow in fall. (Zone 4 to part Zone 3). Sources: 70, 96, 112, IOS, OHH.

Katsura Tree

Cercidiphyllum japonicum
Bushy tree to 45 ft. or more with round, bluish-green leaves. Purplish when young, changing to yellow and scarlet in fall. (Zone 5 to part Zone 4). Sources: 43, 47, 63, NJPR, OHH.

Yellow-Wood

Cladrastis, see Flowering Trees

Hazlenut, Filbert

*Corylus colurna
TURKISH HAZELNUT
Handsome, pyramidal trees to 40 ft. or more with gray, corky bark. Nuts small and without interest. (Zone 4). Sources: OHH.

Russian Olive

Elaeagnus angustifolia
Tree to 20 ft. or tall shrub with silvery branches. Leaves willowy, silvery beneath. Flowers yellowish, not showy but fragrant. June. (Zone 3). Sources: 47, 91, CSN, OHH.

Euptelea

Euptelea polyandra
JAPANESE EUPTELEA
Slender tree to 25 ft. or tall shrub. The round leaves reddish when young, turning yellow and red in fall. (Zone 5). Sources:

Beech

*Fagus sylvatica
EUROPEAN BEECH
Broadly pyramidal tree to 75 ft. with smooth, gray bark and spreading branches. (Zone 5 to part Zone 4). Fairly commonly available.

Fagus sylvatica asplenifolia
FERNLEAF BEECH
Leaves very narrow, often linear. Sources: 43, 97, CSN.

Fagus sylvatica atropunicea (purpurea)
PURPLE BEECH
Leaves coppery-purplish-red. Sources: 91, OHH.

Fagus sylvatica atropunicea riversi
Leaves darker red. Sources: 18, 22, 32, 43, 49, 60, 62, 109, 113, 114, OHH.

Fagus sylvatica fastigiata
PYRAMIDAL BEECH
Tree to 25 ft. Fastigiate in habit. Sources: 2, 14, 43, 53, 113, 114, OHH.

Fagus sylvatica laciniata (heterophylla)
CUTLEAF BEECH
Tree to 45 ft. Leaves deeply dissected. Sources: CSN, OHH.

Fagus sylvatica pendula
WEEPING BEECH
Spreading tree with pendulous branches, to 45 ft. or more. Sources: 14, 28, 114, OHH.

Fagus sylvatica purpureo-pendula
PURPLE WEEPING BEECH
Tree to 45 ft. or more. Sources: 14, 43, 114, OHH.

Fagus sylvatica tricolor
Tree to 25 ft. Leaves spotted white and green with pink margins. Sources: 47, CSN.

Ash

*Fraxinus americana
WHITE ASH
Handsome tree to 80 ft. with broad crown. Leaves turn bronze-purple in fall. (Zone 3). Commonly available.

*Fraxinus excelsior
EUROPEAN ASH
Tree to 80 ft. with broad-oval crown. (Zone 5 to part Zone 4). Sources: OHH.

*Fraxinus excelsior aurea pendula
With yellow pendulous branches to 12 ft. Sources: CSN.

Fraxinus pennsylvanica lanceolata (viridis)
GREEN ASH
Tree to 45 ft. with bright green leaves. Not as good a tree as *F. americana*. (Zone 3). Sources: 4, 45, 48, 70, 96, IOS, OHH.

Ginkgo

Ginkgo biloba
MAIDENHAIR TREE
Handsome tree to 75 or 80 ft. Leaves color golden yellow in fall. (Zone 4 to part Zone 3). Sources: 14, 43, 48, 62, 70, 91, 112, 113, 114, OHH.

Ginkgo biloba fastigiata
Narrowly pyramidal tree to 75 ft. Sources: 43, 63, OHH.

Honey Locust

Gleditsia triacanthos
Graceful tree to 60 or 80 ft. with long, sharp thorns. (Zone 4). Sources: 18, 47, 48, 60, 61, 81, OHH.

Gleditsia triacanthos aurea
SUNBURST LOCUST
Tree to 40 ft. Young leaves bright yellow. Sources: 28, 33, 43, 60, 113, 114.

Gleditsia triacanthos elegantissima
Densely bushy tree to 20 or 25 ft. Thornless. Sources: OHH.

Gleditsia triacanthos inermis
THORNLESS HONEY LOCUST
Like the type but without thorns. Sources: 66, OHH. Selected type: **'Moraine.'** To 50 or 60 ft. Vase-shaped crown. Without thorns or fruit. Sources: 60, 66, 109, 113, many others.

Kentucky Coffee-Tree

Gymnocladus dioica
Tree to 50 or 60 ft. or more with spreading branches and with large, compound leaves which turn clear yellow in fall. (Zone 4 to part Zone 3). Sources: 48, 66, 70, OHH.

Silver-Bell

Halesia, see Flowering Trees

Walnut, Butternut

Juglans cinerea
BUTTERNUT
Tree to 40 or 60 ft. with spreading branches. Planted for the edible nuts. (Zone 3). Sources: 48, 76, OHH.

Juglans nigra
BLACK WALNUT
More handsome tree than *J. cinerea*, to 80 ft. or more. Leaves dark green. (Zone 4 to part Zone 3). Sources: OHH.

Juglans regia
ENGLISH or PERSIAN WALNUT
Broad-headed tree to 60 ft. or more with smooth, gray bark. (Zone 6 to part Zone 5). Sources: 43, 99, 106. Selected type: CARPATHIAN WALNUT. Hardy to Zone 4. Sources: 99.

Kalopanax

Kalopanax pictus (Acanthopanax ricinifolius) CASTOR ARALIA
Tree to 30 ft. or more with spreading, prickly branches and 5-7 lobed leaves of striking appearance. (Zone 4). Sources: OHH.

Goldenrain Tree

Koelreuteria, see Flowering Trees

Sweet Gum

Liquidambar styraciflua
Tree to 60 ft. or more with corky bark. Leaves turn orange to deep crimson in fall. (Zone 4). Sources: CSN, MDTN, OHH.

Liquidambar styraciflua aurea
Tree to 30 ft. Leaves golden-yellow. Sources: OHH.

Tulip Tree

Liriodendron tulipifera
Handsome, pyramidal tree to 80 ft. or more. Leaves turn clear yellow in fall. The large greenish flowers are conspicuous. (Zone 4). Sources: MDTN, OHH, PAFA.

Liriodendron tulipifera fastigiatum
Branches upright forming a narrowly pyramidal head. Sources: OHH.

Magnolia

Magnolia acuminata
CUCUMBER TREE
Pyramidal tree to 70 ft. with large, dark green leaves. Flowers insignificant but the red fruits conspicuous. (Zone 4). Sources: 88, 112, OHH.

Magnolia fraseri
FRASER MAGNOLIA
Tree to 45 ft. with large, bright green leaves, large white flowers and pink fruits. (Zone 6 to part Zone 5). Sources: 14, 88.

Magnolia obovata
WHITE-LEAF JAPANESE MAGNOLIA
Pyramidal tree to 40 or 50 ft. with large leaves. Flowers white, cup-shaped, fragrant. (Zone 5). Sources:

Magnolia tripetala
UMBRELLA MAGNOLIA
Broad headed tree to 30 ft. with large leaves and large, white flowers. (Zone 5 to part Zone 4). Sources: OHH.
For other Magnolias, see Flowering Trees and Flowering Shrubs

Crab-Apple

Malus 'Strathmore'
STRATHMORE CRAB-APPLE
Narrowly pyramidal tree to 35 ft. with dark red leaves and pink flowers. Suitable for tall hedges. (Zone 3). Sources: MDTN.

Mulberry

Morus alba pendula
WEEPING MULBERRY
Tree to 10 or 12 ft. with slender, pendulous branches, fruits pinkish to purple. (Zone 4). Sources: OHH.

***Morus alba tatarica**
RUSSIAN MULBERRY
Round-headed tree to 30 ft. with bright green leaves. Suitable for tall hedges. (Zone 4). Sources:

Sour Gum, Pepperidge, Tupelo

***Nyssa sylvatica**
Tree to 40 or 50 ft. Leaves shiny green, turning scarlet in fall. (Zone 4). Sources: 14, 36, 45, 47, 62, 91, OHH.

Nyssa sylvatica pendula
WEEPING TUPELO
Tree to 25 feet with pendulous branches. Sources:

Hop-Hornbeam

***Ostrya virginiana**
Broadly pyramidal tree to 35 or 40 ft. Light green fruits conspicuous in fall. (Zone 4 to part Zone 3). Sources: OHH.

Parrotia

Parrotia persica
PERSIAN WITCH HAZEL
Tree to 12 or 15 ft. with spreading branches. Leaves turn orange and scarlet in fall. Flowers insignificant. (Zone 5). Sources: 14, 62, 63.

Cork-Tree

***Phellodendron amurense**
AMUR CORK-TREE
Tree to 35 ft. with wide spreading branches and gray, corky bark. (Zone 4 to part Zone 3). Sources: 43, 47, 62, 70, OHH.

Plane-Tree

***Platanus acerifolia** (occidentalis x orientalis)
LONDON PLANE-TREE
Round-headed tree to 80 ft. with flaking bark. Superior to its parents. (Zone 5). Sources: 7, 36, 37, 81, 91, OHH.

***Platanus occidentalis**
SYCAMORE, BUTTONWOOD
Round-headed tree to 100 ft. Trunk and crown less well shaped than *P. acerifolia.* (Zone 5 to part Zone 4). Sources: 29, 48, 62, 106, MDTN, OHH.

***Platanus orientalis**
ORIENTAL PLANE-TREE
Broadly round-headed tree to 75 ft. Usually developing several leaders. (Zone 6). Sources: 6, 62.

Poplar

Populus alba
WHITE POPLAR
Tree to 75 ft. with grayish-white bark. Leaves green above, whitish beneath. (Zone 3). Sources: OHH.

Populus alba nivea
SILVER POPLAR
Leaves lobed, silvery white beneath. (Zone 3). Sources: 17, OHH.

Populus alba pyramidalis (bolleana)
BOLLEANA POPLAR
Handsome, columnar tree to 50 ft. or more with silvery leaves. (Zone 3). Sources: 4, 62, 70, 74, 76, 96, 116, IOS.

Populus berolinensis (laurifolia x nigra italica)
BERLIN POPLAR
Broadly columnar tree to 50 ft. Handsome and hardy. (Zone 3 to part Zone 2). Sources: OHH.

Populus koreana
KOREAN POPLAR
Handsome tree to 50 or 60 ft. with large bright green leaves having a red midrib. (Zone 5 to part Zone 4). Sources: OHH.

Populus maximowiczi
JAPANESE POPLAR
Handsome tree to 60 or 70 ft. with wide-spreading branches. Leaves dark green, whitish beneath. (Zone 4). Sources: OHH.

Populus nigra italica
LOMBARDY POPLAR
Narrowly columnar tree to 50 or 60 ft. (Zone 4 to part Zone 3). Sources: OHH.

Populus simoni
CHINESE POPLAR
Tree to 35 ft. with oval crown and rather small bright green leaves. (Zone 4 to part Zone 3). Sources: OHH.

Populus simoni fastigiata
Narrowly columnar. Handsomer but less tall than the Lombardy Poplar. Sources: OCN.

Populus suaveolens
MONGOLIAN POPLAR
Handsome tree to 40 ft. or more with large, oval, dark green leaves. (Zone 3). Sources:

Plum, Cherry

Prunus cerasifera atropurpurea (P. pissardi)
PURPLE-LEAF PLUM
Tree to 12 or 15 ft. with purplish-red leaves and pink flowers. (Zone 4). Sources: 53, 86, 114, OHH. Selected type: **'Thundercloud.'** Leaves very dark red. Sources: 48, 112, PAFA.

Prunus maacki
AMUR CHOKE CHERRY
Tree to 30 ft. with conspicuously reddish-brown, flaky bark. Flowers white. (Zone 3 to part Zone 2). Sources: OHH.

Prunus serotina
BLACK CHERRY
Tree to 60 ft. or more with long and narrow, shiny green leaves. Flowers white. (Zone 3). Sources: OHH.
For other Cherries and Plums, see Flowering Trees and Flowering Shrubs

Pear

Pyrus betulaefolia
BIRCH-LEAF PEAR
Tree to 25 ft. with spreading, somewhat pendulous branches and shiny green leaves. Flowers white. (Zone 4). Sources: OHH.

Oak

Quercus alba
WHITE OAK
Tree to 75 ft. with spreading branches. Leaves bright green, turning purple in fall. (Zone 4). Sources: 48, 76, 109, 112, OHH.

Quercus borealis (rubra)
RED OAK
Tree to 75 ft. Leaves turn dark red in fall. (Zone 4 to part Zone 3). Sources: CSN, JPR, OHH.

Quercus cerris
TURKEY OAK
Pyramidal tree to 75 ft. Leaves remain green until late in fall. (Zone 6 to part Zone 5). Sources: OHH.

Quercus coccinea
SCARLET OAK
Round-headed tree to 60 ft. with bright green leaves, turning scarlet in fall. (Zone 4 to part Zone 4). Sources: OHH.

Quercus imbricaria
SHINGLE OAK
Broadly pyramidal tree to 50 ft. with shiny green, narrow leaves turning bronze-red in fall. (Zone 5). Sources: 47, OHH.

Quercus lyrata
OVERCUP OAK
Round-headed tree to 75 ft. with large leaves. (Zone 5). Sources:

Quercus macrocarpa
BUR OAK
Tree to 75 ft. with corky, spreading branches and shiny dark green leaves. (Zone 3). Sources: OHH.

Quercus montana (prinus)
CHESTNUT OAK
Tree to 50 or 60 ft. with chestnut-like, shiny leaves, turning orange in fall. (Zone 4). Sources: 42, 43, 109, OHH.

Quercus nigra
WATER OAK
Tree to 60 ft. with slender branches and conical head. Leaves bluish-green. (Zone 7). Sources: 42, 45, 109.

Quercus palustris
PIN OAK
Handsome pyramidal tree to 75 ft. Leaves color brightly in fall. (Zone 4). Sources: JPR, OHH.

***Quercus phellos**
WILLOW OAK
Tree to 50 or 60 ft. with conical head and willow-like leaves turning yellow in fall. (Zone 5). Sources: 14, 18, 32, 43, 45, 66, 109, OHH.

***Quercus robur**
ENGLISH OAK
Tree to 60 or 70 ft. with spreading branches. Leaves remain green late in fall and do not color. (Zone 4). Sources: 18, 61, 70, 109, 114, OHH.

Quercus robur fastigiata
COLUMNAR ENGLISH OAK
Broadly columnar tree to 50 ft. (Zone 4). Sources: CSN, OHH.

***Quercus variabilis**
CHINESE CHESTNUT OAK
Tree to 50 or 60 ft. with corky bark and handsome, chestnut-like leaves. (Zone 5). Sources: OHH.

***Quercus velutina**
BLACK OAK
Tree to 75 ft. with shiny dark green leaves turning red or orange in fall. (Zone 5 to part Zone 4). Sources: OHH.

***Quercus virginiana**
LIVE OAK
Evergreen tree to 40 or 50 ft. with horizontally spreading branches and shiny dark green leaves. (Zone 7). Sources: 42, 45.

Locust

Robinia pseudoacacia aurea
YELLOW-LEAVED BLACK LOCUST
Tree to 30 or 40 ft. with graceful bright yellow foliage. (Zone 4). Selected type: **'Friesia.'** Young thorns reddish. Young leaves orange-yellow. Sources: 113.

Robinia pseudoacacia bessoniana
With slender twigs and umbrella-shaped crown. Rarely flowers. (Zone 4). Sources:

Robinia pseudoacacia pyramidalis (fastigiata)
Narrowly columnar. Rarely flowers. (Zone 4). Sources: 113.

Willow

Salix alba chermesina
REDSTEM WHITE WILLOW
Tree to 40 ft. or more with bright red, spreading, arching branches. (Zone 3). Sources:

Salix alba tristis (vitellina pendula)
WEEPING WHITE WILLOW
Tree to 40 ft. or more with slender, bright yellow, pendulous branches. (Zone 3). Sources:

Salix amygdaloides
PEACH-LEAVED WILLOW
Tree to 30 ft. or more with ascending shiny orange branches. (Zone 4). Sources:

Salix babylonica
Weeping Babylon Willow
Tree to 20 or 25 ft. with brown, long pendulous branches. Commonly confused in the trade with *S. blanda* and *S. elegantissima*. (Zone 6 to part Zone 5). Sources: 38, 66, 109.

Salix babylonica crispa
Ring-Leaf Willow
Tree to 20 ft. with folded and spirally curved leaves. (Zone 6 to part Zone 5). Sources: OHH.

Salix blanda (babylonica x fragilis) **'Niobe'**
Wisconsin Weeping Willow
Tree to 40 ft. or more with wide-spreading head and long, pendulous branches. (Zone 4 to part Zone 3). Sources: 56, OHH.

Salix elegantissima
Thurlow Weeping Willow
Tree to 40 or 50 ft. with shiny brown, long pendulous branches. (Zone 4 to part Zone 3). Sources: 48, 49, 54, 96, 112, OHH.

Salix matsudana tortuosa
Contorted Hankow Willow
Tree to 20 ft. with spirally twisted and contorted branches. (Zone 5 to part Zone 4). Sources: 91, CSN, OHH.

Salix pentandra
Laurel Willow
Handsome tree to 40 ft. with ascending shiny brown branches and shiny dark green leaves. Catkins golden-yellow. (Zone 4). Sources: 76, 81, IOS, OHH.

Salix sepulcralis (salamoni) (babylonica x alba)
Fast-growing tree to 40 or 50 ft. with spreading branches and pendulous branchlets. Less weeping than *blanda* and *elegantissima* and less hardy. (Zone 5 to part Zone 4). Sources: 113, OHH.
For other Willows, see Flowering Shrubs and Shrubs for Foliage.

Sassafras

Sassafras albidum
Tree to 40 or 50 ft. with distinctive bright green leaves, turning orange and scarlet in fall. (Zone 5 to prt Zone 4). Sources: OHH.

Pagoda-Tree, Scholar-Tree

Sophora japonica pendula
Weeping Japanese Pagoda-Tree
Picturesque tree to 15 ft. with tortuous limbs and pendulous branches. (Zone 5). Sources: 14, 63.

Mountain-Ash

Sorbus alnifolia
Korean Mountain-Ash
Densely round-headed tree to 40 or 50 ft. Leaves bright green, turning orange and scarlet in fall. (Zone 5 to part Zone 4). Sources: 63.

Sorbus aria
White Beam-Tree
Broadly pyramidal tree to 30 or 35 ft. Leaves bright green, white beneath. R fruits conspicuous in fall. (Zone 5 Sources:

Sorbus aucuparia
European Mountain-Ash, Rowan
Round-headed tree to 40 ft. Berries brig red, showy. (Zone 3). Sources: NJP OHH.

Sorbus aucuparia columnaris
Columnar Mountain-Ash
Sources: OCN, OHH.

Sorbus aucuparia fastigiata
Pyramidal Mountain-Ash
Sources: OHH.

Sorbus aucuparia pendula
Weeping Mountain-Ash
To 12 or 15 ft. Sources: OHH.

Sorbus torminalis
Service-Tree
Round-headed tree to 50 ft. Leaves lig green, turning bright red in fall. (Zone to part Zone 5). Sources:

Sorbus vilmorini
Chinese Mountain-Ash
Tree to 12 or 15 ft. with fine, fern-li foliage and rosy-pink berries. (Zone 5 Sources: 113.

Linden

Tilia americana fastigiata
Pyramidal American Linden
Narrowly pyramidal tree to 75 ft. w large leaves. (Zone 3). Sources: OHH.

Tilia cordata
Small-Leaved European Linden
Round-headed tree to 60 ft. Leaves hea shaped, bluish beneath. Flowers v fragrant. June-July. (Zone 3). Sourc 28, 61, 62, 70, 71, 81, 109, 112, OHH.

Tilia euchlora
Crimean Linden
Handsome tree to 50 ft. with shiny, da green leaves. (Zone 4). Sources 43, OHH.

Tilia europaea (vulgaris) (cordata x p typhyllos)
Common European Linden
Tree to 75 ft. Leaves dark green abo light green beneath. (Zone 4 to part Z 3). Sources: 47, 81, OHH.

Tilia petiolaris
Weeping Silver Linden
Handsome tree to 60 ft. Leaves wh beneath, pendent on long stalks. (Zone Sources:

Tilia platyphyllos fastigiata (pyramidal)
Large-Leafed European Linden
Narrowly pyramidal tree to 50 or 60 with rather large leaves. (Zone 4). Sourc OHH.

lia tomentosa
LVER LINDEN
ndsome, broad-pyramidal tree to 75 ft. th stout branches. Leaves dark green ove, white beneath. (Zone 5 to part ne 4). Sources: 14, 43, 81, OHH.

Elm

itch Elm disease makes it unwise to ant. See **'Christine Buisman'** below.

mus alata
INGED ELM
ound-headed tree to 35 ft. with winged anches and small, dark green leaves. one 5). Sources: 66.

mus americana
MERICAN ELM
ndsome tree to 80 ft. or more with reading branches. (Zone 2). Sources: JPR, OHH.

mus americana columnaris
adly columnar tree to 60 ft. (Zone 4). urces: OHH.

mus americana 'Moline'
OLINE ELM
one 4). Sources: NJPR, OHH.

mus carpinifolia (foliacea)
OOTH-LEAVED EUROPEAN ELM
ee to 75 ft. with slender, ascending anches. (Zone 4).

lected types: **cornubiensis**
RNISH ELM
own narrowly pyramidal. Sources:

rniensis
RSEY ELM
anches more stiffly erect. Sources:

hristine Buisman'
uropean Elm reputed to be resistant to th the Dutch Elm disease and phloem erosis. Tree to 90 ft. Holds leaves late; es not have the spreading, open-top char- teristic of American Elm. (Zone 4). urces: 62, 70, many others.

mus glabra
SCH ELM
ee to 75 ft. with smooth trunk. (Zone to part Zone 3). Sources: OHH.

mus glabra camperdowni
EEPING ELM
ee to 12 or 14 ft. with contorted branches d weeping branchlets. (Zone 4 to part ne 3). Sources: OHH.

mus hollandica (glabra x carpinifolia)
lected types: **belgica** (latifolia)
ee to 75 ft. with broad crown and raight stem. (Zone 4). Sources:

emmer
arrowly pyramidal tree to 75 ft. with cending branches. Sources:

geta
UNTINGDON ELM
ree to 75 ft. with large, rounded crown. urces:

Ulmus parvifolia
CHINESE ELM
Round-headed tree to 30 ft. with small leaves, remaining green until late winter. (Zone 6 to part Zone 5). Sources: OHH.

Ulmus procera (campestris)
ENGLISH ELM
Oval-headed tree to 80 ft. or more with spreading or ascending branches. (Zone 5 to part Zone 4). Sources: OHH.

Ulmus procera purpurea
Leaves tinged dark purple. (Zone 5). Sources:

Ulmus pumila
SIBERIAN ELM
Graceful tree to 50 ft. or more with rather small leaves. (Zone 3). Sources: NJPR, OHH.

Zelkova

Zelkova serrata
JAPANESE ZELKOVA
Broadly round-headed tree to 50 ft., usually with short trunk. (Zone 5). Sources: 43. NJPR, WBC.

R. A. Smith

The white blossoms of European mountain-ash (*Sorbus aucuparia*) are followed by showy clusters of red berries

LIST OF NURSERIES

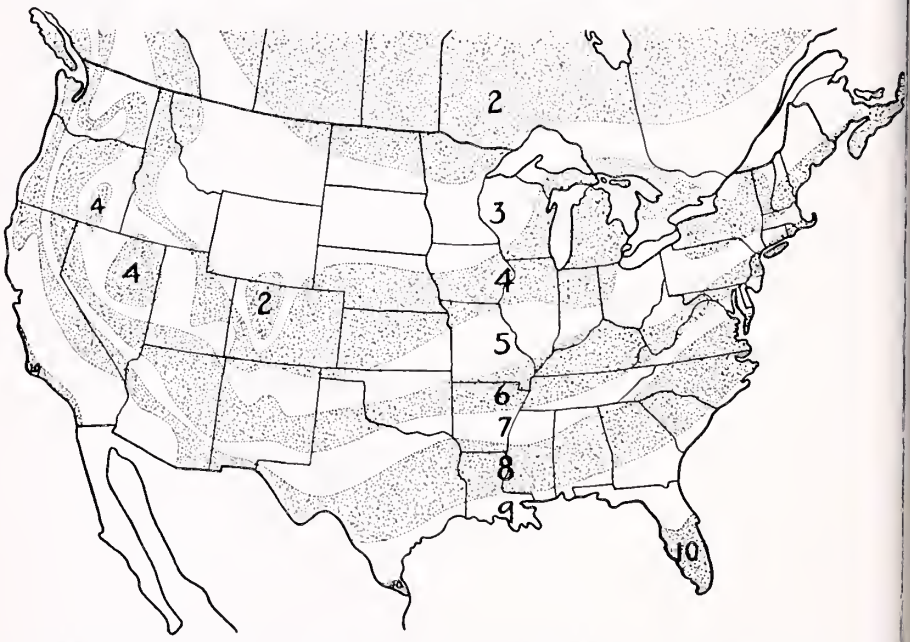
1. Adams Nursery, Inc., Box 525, Westfield, Mass.
2. Alanwold Nursery, Neshaminy, Bucks Co., Pa.
3. J. H. Alexander, Middleboro, Mass. Alpines, lilacs, blueberries

CAG. Alpenglow Gardens (Michaud & Co.), 13328 Trans-Canada Highway, New Westminster, B. C., Canada. Hardy alpines, perennials and shrubs

4. Andrews Nursery, Faribault, Minn.
5. Armstrong Nurseries, 408 N. Euclid Ave., Ontario, Calif. Roses, camellias
6. Bagatelle Nurseries, Box 196, Huntington Station, N. Y. W&F
   (Stock not presently certified for shipment outside Japanese beetle zone)
7. Barnes Bros. Nursery Co., U.S. Rte. 5, Wallingford, Conn. W&
10. Bunting's Nurseries, Inc., Selbyville, Del.
12. Bonnell Nurseries, 14455 Rainier Ave., Renton, Wash.
14. Brimfield Gardens Nursery, 245 Brimfield Rd., Wethersfield, Conn.
    Rare trees and shrubs
15. Brownell Holly Farm, Box 5965, Milwaukee, Ore. Hollies W&
16. Burgess Seed and Plant Co., Galesburg, Mich.
    Evergrees, flowering trees and shrubs, nut trees
17. California Nursery Co., Niles, Calif.
18. Cape Cod Nurseries, (H. V. Lawrence, Inc.) Falmouth, Mass. W&
20. Carroll Gardens, Westminster, Md. W&
22. Cherry Hill Nurseries, West Newbury, Mass.
23. Clarendon Gardens Nursery, Linden Rd., Pinehurst, N. C. W&
    Hollies, camellias, azaleas

* *Wholesale & Retail*

MAP SHOWING ZONES OF HARDINESS IN THE UNITED STATE



In using the zone map it must be kept in mind that the zones are only approximate, and that there are many variations within each zone. Altitude and exposure can result in a climate quite different from the "average climate" of any given region. A wide range of climates may exist ev within the confines of a single garde and the alert gardener will seek these o and make use of them to successfu grow plants far outside their commo accepted range.

BC.	W. B. Clarke & Co., Box 343, San Jose 3, Calif.	W
CN.	The Cole Nursery Co., Painesville, Ohio	W
4.	The Conard-Pyle Co., West Grove, Pa. Roses, old varieties and species, chrysanthemums	
YC.	Curtis Nurseries, Inc., Callicoon, N. Y.	W
8.	Detmer Nurseries, Tarrytown, N. Y.	W&R
9.	George Ehrle Nursery, Clifton, N. J. No catalog.	
0.	Earle Dilatush's Holly Nursery, R.F.D. 1, Robbinsville, N. J. Hollies	
1.	Eastern Nurseries, Holliston, Mass. Rare and unusual evergreens, alpines	W&R
2.	Eastern Shore Nurseries, Inc., Box 743, Easton, Md.	W&R
3.	Emlong Nurseries, Inc., Stevensville, Mich.	
AFA.	Fairview Evergreen Nurseries, Fairview, Pa.	W
5.	Farmer Seed and Nursery Co., Faribault, Minn. Hardy trees and shrubs	
6.	F & F Nurseries, 277 Milltown Rd., Springfield, N. J.	
LCF.	Charles Fiore Nurseries, Prairie View, Ill. Flowering trees and shrubs, evergreens	W&R
7.	Alexander Forbes & Co., Morris Turnpike, Millburn, N. J.	
8.	Fruitland Nurseries, Box 910, Augusta, Ga. Broad-leaved evergreens, flowering shrubs, etc.	W&R
9.	Joseph B. Gable, Stewartstown, Pa. Rhododendrons, azaleas	
0.	James I. George & Son, Inc., Fairport, N. Y. Clematis	W&R
2.	Glen Saint Mary Nurseries Co., Glen Saint Mary, Fla. Azaleas, camellias	
3.	Girard Nurseries, Geneva, Ohio. Small potted trees suitable for training as bonsai; seeds of evergreen trees; flowering trees and shrubs, evergreens, etc.	
AGR.	Greenbrier Farms, Inc., Norfolk, Va. Broad- and narrow-leaved evergreens; flowering trees and shrubs	W
5.	Griffing Nurseries, Beaumont, Tex. Specialize in plants native to southeast Texas	W&R
6.	Hanley's Nursery, Carboudale, Ill.	
7.	Hicks Nurseries, Inc., Westbury, N. Y. Flowering trees and shrubs, broad- and narrow-leaved evergreens, etc.	W&R
LHD.	Hill Dundee Nursery Co. Dundee, Ill.	W
8.	Hillenmeyer Nurseries, Lexington, Ky.	W&R
9.	C. M. Hobbs & Sons, Inc., Bridgeport, Ind.	W&R
0.	Hopkins Nursery, Bothell-Kirkland Highway, Bothell, Wash. Flowering trees, shrubs, vines, evergreens	
HH.	Horton Nurseries, Inc., Painesville, Ohio Probably the largest collection of species and varieties of trees and shrubs, etc. in all categories	W
3.	Howell Nurseries, Inc., Boyd's Bridge Road, Knoxville, Tenn.	W&R
4.	The Stephen Hoyt's Sons Co., Inc., 46 Carter St., New Canaan, Conn. Flowering trees and shrubs, etc.	W&R
5.	Ilgenfritz Nurseries, Inc., Monroe, Mich. Roses, evergreens, flowering trees and shrubs, dwarf shrubs	W&R
6.	Inter-State Nurseries, Hamburg, Iowa	
7.	Ivy Hill Forest, Cockeysville, Md.	W&R
8.	Jackson & Perkins Co., Newark, N. Y. Roses (also, Perkins-De Wilde Nurseries, Shiloh, N. J., Evergreens, shrubs, azaleas)	
9.	Kansas Landscape and Nursery Co., 1416 East Iron Ave., Salina, Kan.	
0.	Kelly Bros. Nurseries, Inc., Dansville, N. Y. Evergreens, fruit trees, shrubs	
1.	Kelsey-Highlands Nursery, East Boxford, Mass.	W&R
2.	Kelsey Nursery Service, Highlands, N. J.	
3.	Kingsville Nurseries, Kingsville, Md. Hollies, evergreens. Catalog not available for 1960	
4.	The Krider Nurseries, Inc., Middleburg, Ind.	W&R
5.	La Bar's Rhododendron Nursery, Stroudsburg, Pa. Rhododendrons, azaleas, other ericaceous plants	W&R
6.	Laird's Nurseries, 8900 Broad Street Rd., Richmond, Va. Flowering and shade trees, broad-leaved evergreens, flowering shrubs	
7.	Lamb Nurseries, E. 101 Sharp Ave., Spokane 2, Wash. Alpines, flowering shrubs, vines	
8.	H. L. Larson, 3656 Bridgeport Way, Tacoma 66, Wash. Rhododendrons and azaleas, dwarf species and hybrids	

69. Marjorie Lester Gardens, 959 Browns Valley Rd., Watsonville, Calif.
Old and new rose varieties

70. The Lin County Nurseries, Center Point, Iowa

71. Littlefield-Wyman Nurseries, Inc., Abington, Mass. W&R

74. May Nursery Co., Yakima, Wash. W&R

75. Mayfair Nurseries, R.D. 2, Nichols, N. Y.
Alpines heather, dwarf conifers

76. McKay Nursery Co., Madison, Wis.
Trees and shrubs, for the Northwest W

ORMN. Mitsch Nursery, Aurora, Ore.
Lining out stock of evergreens, flowering shrubs, etc.

79. Musser Forests, Inc., Indiana, Pa. Evergreens, shade trees W&R

80. Neosho Nurseries, Inc., Neosho, Mo. Roses, flowering trees and shrubs

81. Oak Park Nurseries, Inc., East Patchogue, N. Y.
Flowering trees and shrubs W

NJPR. Princeton Nurseries, Princeton, N. J.

85. Putney Nursery, Inc., Putney, Vt. Hardy ericaceous and native plants

86. Rich & Sons Nursery, Hillsboro, Ore. W&R
Shade and flowering trees, crab-apple specialists

88. E. C. Robbins, (Gardens of the Blue Ridge), McDowell Co., Ashford, N. C.
Native trees, shrubs and wild flowers

90. Frank H. Rose, 1020 Poplar St., Missoula, Mont. W&R
Rare plant collector, native plants of the Northwest, alpines

91. Rosedale Nurseries, Saw Mill River Parkway, Hawthorne, N. Y.
Evergreens, flowering trees and shrubs

92. Rosemont Nurseries, Tyler, Tex. Roses W&R

93. A. P. Saunders Hybrid Peonies (Miss Silvia Saunders, Owner),
Clinton, N. Y. (Visitors welcome)

94. Scharff's Nursery, Inc., New Carlisle, Ohio

IOS. The Shenandoah Nurseries, Shenandoah, Iowa W

CSN. Sheridan Nurseries, Box 181, Islington, Toronto, Canada
Shade, flowering trees and shrubs W&R

96. Sherman Nursery Co., Charles City, Iowa W&R

CMD. Skinners Nursery, Ltd., Dropmore, Manitoba, Canada Hardy shrubs, etc.

99. Gilbert L. Smith & Sons Nursery, R. D. 2, Millerton, N. Y.
Nut tree specialists

101. Stark Bros. Nurseries and Orchards Co., Louisiana, Mo.
Shade and flowering trees and shrubs, etc.

102. Carl Starker Gardens, Jennings Lodge, Ore.
Alpines, dwarf shrubs, rare plants

103. State Nursery & Seed Co., Helena, Mont.

104. Stocking's Rose Gardens, Rte. 5, Box 42, San Jose, Calif. Roses

105. Ten Oaks Nursery and Gardens, Inc., Clarksville, Md.
Azaleas, rhododendrons, hollies, camellias

106. Texas Pecan Nursery, Box 119, Tyler, Tex. W&I
Nut trees, deciduous trees and shrubs

MDTN. Tingle Nursery Co., Pittsville, Md. W&I
Evergreens, flowering trees and shrubs, etc.

107. Will Tillotson's Roses, 802 Brown Valley Rd., Watsonville, Calif.
Old and new rose varieties

109. Upper Bank Nurseries, Inc., Media, Pa.
Shade and flowering trees and evergreens; shrubs; some unusual species

110. Upton Nursery Co., Goodrich, Mich. Lilacs

NJJV. John Vermeulen & Son, Neshanic Station, N. J. V

112. Waynesboro Nurseries, Waynesboro, Va. W&I

113. Wayside Gardens, Mentor, Ohio Shade and flowering trees and shrubs

114. Weston Nurseries, Inc., Route 135, East Main St., Hopkinton, Mass. W&I

MOW. Wild Bros. Nursery Co., Sarcoxie, Mo.
Evergreens, flowering shrubs, peonies

117. Melvin E. Wyant, Rose Specialist Inc., Johnny Cake Ridge, Mentor, Ohio
Old and new varieties of roses

119. Holly by Golly, St. James, N. Y. Hollies. No catalog; will not ship

Note: With some exceptions, letters indicate **wholesale only** (see inside front cover).

ROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

GARDENS OF WESTERN EUROPE

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W SERIES
No. 2

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PLANTS & GARDENS

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Editorial

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and the Editorial Committee of the Brooklyn Botanic Garden

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This Handbook on the Gardens of Western Europe is for gardeners who seek the unusual in travel and for those who enjoy the history of their art first-hand or in picture story. Gardens of the Renaissance as well as those of ancient Pompeii live today in restorations or in carefully nurtured originals. To see these together with the modern gardens of Europe can be an easily realized pleasure for the traveler who knows what there is, and plans ahead to see it. We hope this Handbook will be your guide to some of these living treasures. For lack of space, Great Britain and Eire have been completely omitted, and the gardens of Scandinavia have only token representation here. We hope that a later Handbook can feature gardens of these countries.

Editor Meyer writes from first-hand experience, and the collaborating authors are describing gardens with which they are closely familiar, in some instances being responsible for their construction and/or operation. Many of the pictures are Dr. Meyer's own; for others we are deeply indebted to the many persons and organizations listed on page 96.

Dr. Meyer is also acquainted with most of the nurseries listed on pages 94 and 95. Some of them have special display gardens. To visit such places will be a stimulating adventure for garden-minded tourists. While the difficulties of plant importation may be too great for most citizens of the U.S.A., every enthusiastic plantsman will be eager to see what is commercially available in Europe.

Most of the public parks and gardens described here are open at all times. The semi-public and private gardens may be seen by special arrangement. Out of his experience on several extended trips to Europe, Dr. Meyer notes that "An entrée can be gained to almost any place if one follows the common courtesy of writing to the owner beforehand. Most of the owners are happy to show their gardens to appreciative visitors."

It is not easy for a foreign traveler to discover the "tone" or "flavor" of a country if he gives all his time to the usual tourist attractions; a self-conducted garden tour can do much to enrich a travel experience.

It is a special pleasure to acknowledge the services of Miss Carol H. Woodward, who prepared the materials in this Handbook for publication, and has seen it through the press.

Sincerely yours,

George S. Avery

Director

WESTERN EUROPEAN LOCALITIES
WITH PARKS AND GARDENS FEATURED IN THIS GUIDE
(Same fifty additianal places are mentianed in the text)
SWEDEN
FINLAND
NORWAY
Akerselva
Naantali
Turku
Uppsala
Oslo
Stockholm
Göteborg
DENMARK
Lund
Copenhagen
NETHERLANDS
Hamburg
Haarlem
Leiden
Bremen
Berlin
Amsterdam
Hanover
The Hogue
Utrecht
Rotterdam
Dortmund
EAST GERMANY
POLAND
Antwerp
Bastoop
Essen
Kassel
Bruges
Ghent
WEST
Brussels
Liége
BELGIUM
LUX.
Frankfort
CZECHOSLOVAKIA
ATLANTIC
OCEAN
Paris
Saarbrücken
Versailles
Seine
GERMANY
Linz
Vienna
Rhine
Munich
Danube
Loire
Gormisch
Salzburg
AUSTRIA
HUNGARY
Nogent-sur-Vernissan
Zurich
L. Constance
Innsbruck
Graz
Bern
Geneva
SWITZ
Lugana
L. Garda
FRANCE
L. Como
L. Lugano
L. Maggiore
Locarno
Poduo
YUGOSLAVIA
Genoa
Bologna
Montpellier
THE RIVIERA
Florence
MONACO
ITALY
Oporto
Bussaco
SPAIN
Blanes
Rame
Coimbra
Barcelona
Pompeii
PORTUGAL
Madrid
Tagus
Aranjuez
Lisbon
Cordova
Polermo
Seville
Guadalquivir
MEDITERRANEAN
SICILY
Granado
SEA

AUSTRIA

Many new parks reflect the people's age-old love of flowers and greenery

IN Austria, where a love of plants is part of every person's heritage, the goal today is to bring nature into the cities—to eliminate the drab slums and increase the number of parks. In a new frame of "gardens and green spaces" the mayor of Vienna envisions an open and spacious urban landscape that will "rejuvenate the old city and thus enable many healthy, strong and handsome men and women to build a better world."

Those who revisit Vienna will be impressed by the new "urban green" as they seek out the old gardens they remember: Belvedere Park with its old castle and extensive rock garden; the Burggarten, the Volksgarten, and Augarten (a naturalized area); and the Botanical Garden of the University of Vienna. Anlagen (landscaped areas) not to be missed include Rathauspark, Türkenschanz Park, and the new garden for the blind in Wertheimsteinpark.

An illustrated booklet on Vienna's parks "Soziales Grün in Wien," with an English translation, may be obtained by addressing: Magistrat der Stadt Wien, Magistratsabteilung 42, Stadtgartenamt, Vienna 3, Austria.

Nearby Baden has been called the "Garden City of the Gates of Vienna." There are three great parks here: Doblhofpark, with avenues of trees, a large pond, and other attractions; the Bahnhofpark; and, best known of all, the Kurkpark, which was established in 1758. Many of the area's old trees are still standing. Here is the Beethoven Temple, the music pavilion, electric flower clock, and the "flower paradise" built on a hillside. The place is a botanist's happy hunting ground.

Also in the vicinity of Vienna are the park at Laxenburg, with its many fine conifers; Wachau, where the native flora is especially interesting; the park of the castle of Count Harrack at Bruck, and Laudonpark, a memorial forest at Hadersdorf.

At Frohnleiten, in Styria (Steiermark),

Long avenues of tall pleached lindens characterize the grounds of Schönbrunn Palace in Vienna. A royal residence during four and a half centuries, Schönbrunn is now publicly owned and is open to visitors.

Raised flower beds are outlined with rails in Vienna's Garden for the Blind.

on the road between Vienna and Bruck, is one of the finest botanical gardens in Austria. This is on the estate of Baron Maier-Melnhof. The alpine garden there is especially noteworthy. At Graz, not far distant, a botanical garden is associated with the university.

In Upper Austria, gardens well worth visiting include the parks and botanical garden at Linz; and the rose garden and rhododendron valley of the Freinberganlage. At Salzburg, the park of Castle Mirabel, with its fountains, and the gardens of Castle Hellbrunn have been developed especially for visitors to the annual music festival.

To be seen at Innsbruck in the Tyrol are the park of Castle Ambras and the Hofgarten in the Nordkette mountain range. This famous garden was first opened in 1410 as a garden of native plants. Many of the trees here, mostly spruces, are hundreds of years old; one was planted by the Empress Maria Theresa. One of the beeches in the area of the original garden has a circumference exceeding 22 feet.

Austria's two outstanding parks, one old, the other new, are the Schönbrunn Palace grounds and the Park for the Blind, both in Vienna. The Schönbrunn Schlosspark was founded in the 14th cen tury, but its present name was not adopt ed until much later. About 1668 a hunt ing party stumbled upon a beautifu spring there, and the name Schöne Brun was accordingly given to the place. A botanical garden was founded there b Emperor Francis Joseph I in 1753. Sinc 1918 it has been under the direction o the state.

The Park for the Blind was complete in 1959. Operated jointly by the Depar ment of Gardens of Vienna and the So ciety for the Blind, it covers 6,000 squar meters in Werthheimstein Park. Braill plates at its entrance describe the garde and all the plants are labeled in Braill Plants have been selected for fragranc and taste. There are benches and chai along the walks, a clubhouse, stalls fo dogs, an acoustical fountain for pleasa sound, and a small zoo. There is also small garden area especially for childre Railings and curbs carefully installed e able the blind to tour the garden witho being helped.

Further information about parks an gardens in Austria can be obtained Vienna from the Horticultural Societ (Oesterreichische Gartenbaugesellschaft Parkring 12.

A winding pathway invites one to stroll in Hartäckerpark, Vienna. The city maintains 800 refreshing open spaces of trees and lawns and flowers.

Stones are effectively used for walls and walks in many Austrian home gardens. *Above:* The stairway that leads to a pine-shaded garden house is flanked by perennials that bloom from spring to autumn. *Below:* Grapes grow on the lattice that separates the living area from the vegetable garden.

BELGIUM

Classical influence pervades the gardens in a country famed for its nurseries

BELGIUM has long been one of the continent's important centers for commercial production of ornamental plants. The city of Ghent, where the industry is centered, has had a botanical garden since 1797, and a notable flower show since 1809.

The country's horticultural renown has been continuous, and today the export of azaleas and tuberous begonias, particularly, has assumed major proportions.

The beautifully kept parks and public gardens of Belgium reveal the people's long-enduring love for cultivated plants. The classical and baroque periods, when many elaborate gardens were developed, has left its influence on the country. Many such classical gardens are still to be seen today throughout the land.

Modern private gardens, although smaller and much less pretentious than the gardens of old, are noteworthy for the originality with which aspects of the classical era have been combined with the architectural features of the 20th century.

New Botanic Garden at Meise

The Botanic Garden of Brussels, which has long been established near the center of the city, is soon to be transferred to Meise, just north of the city. The new location is in one of the most sumptuous parks of Europe, covering more than 100 acres and adorned with magnificent old trees, two lakes, and a 10th century castle. When completed, the institution will be one of the most spacious and well appointed botanic gardens of Europe.

Institutions and Schools

Although the new garden at Meise soon is to replace the old one, the Botanic Garden in Brussels still is worth a visit. Another botanic garden to see is at Liége, on Rue Fuchs.

There are several horticultural schools and research centers in Belgium. The principal ones are at Vilvoorde, near Brussels, and at Melle, near Ghent. Agronomical studies and experiments are carried on in institutions at Ghent, Gembloux, and Louvain.

Nursery Regions

Each section of the west-central part of Belgium has its specialties in the commercial cultivation of plants. Ornamental trees, shrubs, and conifers are grown principally in the region of Wetteren, 15 miles from Ghent, and around Maldegem, 20 miles from Ghent. Ornamental pot plants are likewise grown in the vicinity of this floral capital, particularly

The park at the Château of Belœil is said to be the finest of the historical gardens of Belgium.

at Lochristien, Merelbeke, Melle, and De Pinte, and also in the region of Bruges.

Near Brussels will be seen great glasshouses where ornamentals are forced for early flowering, and others where table grapes are cultivated. Cut flowers are grown near Aalst (Alost), between Brussels and Ghent, with Moorsel as the most important center.

Arboretum Kalmthout

About 20 miles north of Antwerp on the main rail line to the Netherlands is Kalmthout, which is probably the finest private arboretum in all Belgium. The older part of the collection dates from 1857 when the property became the nursery of Charles van Geert, for nearly a half-century one of the most important nurseries of Europe—a place well known for exotic trees, shrubs, and especially for the famous van Geert azaleas.

Since 1951, when the present owners acquired the property, the derelict nursery has been transformed into the private arboretum of the de Belder family. Remaining from the original nursery is a wealth of rare trees, many nearly 100 years old. A long avenue of conifers up to 50 feet tall has developed from the nursery rows planted in the days of van Geert. The collection is particularly rich in plants from Japan, some of which are thought to be the original ones brought in by the great explorer von Siebold on his now famous expedition of the mid-19th century.

The present owners are busily adding to the already noteworthy collection and beautifying the grounds along modern lines. This garden gives promise of ranking as one of the important private arboreta of Europe.

Although it is not open to the general public, Mr. Robert de Belder, the owner welcomes visitors upon application. The arboretum covers about 20 acres of flat terrain.

The Ghent Floralies is one of Europe's largest and most important indoor flower shows. Dating from 1809, it is the continent's oldest exhibition of ornamental plants. Exhibitors come from all parts of Europe to display their specimens and their choice collections. Plants rather than gardens are featured. The pride with which the Belgians present their displays of azaleas, tuberous begonias, and orchids reflects the importance of these plants in Belgian horticulture today. The illustration shows the spring 1960 exhibition.

Austere formality keynotes these two Belgian gardens, and a classical heritage reveals itself in both. *Above:* Paved areas, graveled walks, sternly disciplined evergreens, and geometric flower beds lend dignity to the Brussels garden. *Below:* The floral star fantasy, neatly clipped lawn, and flower beds defined by walks and walls present another example of Belgian style. Order prevails in both these modern gardens: no weed would dare appear.

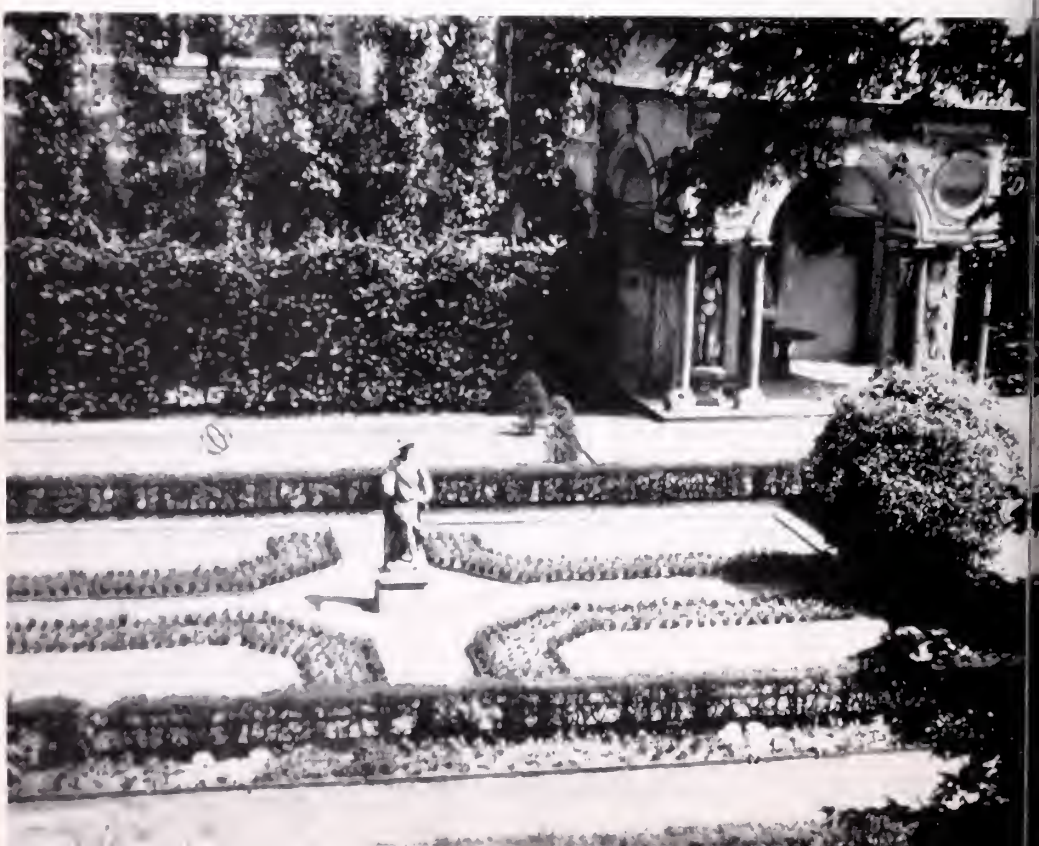
The Garden of Rubens

Ralph E. Griswold

The home garden of Peter Paul Rubens, created by and for himself, is a masterpiece of baroque design. The studio-home of this painter, diplomat, and garden artist, tightly compressed on a narrow street in the heart of Antwerp, provides a dramatic entrance to his garden, part of which is shown below. The sumptuous baroque entrance from the house is at the left.

Rubens started his house in 1610, at age 33, but it was seven years before it was completed for occupancy. A famous Rubens painting of the garden made after 1630 hangs in the Munich Pinakothek.

The Rubens garden is precisely the type one would expect a man of his character to design for himself—bold, robust, fanciful, and original. Quite unlike anything created before, it bears the distinguishing quality of his genius.



Upper left: Trees closely planted along a highway are a familiar sight in Belgium's level countryside. *Upper right:* Rhododendrons are grown as trees in the park adjacent to the Royal Greenhouses in Brussels. *Lower left:* A wall garden separates the planted pavement from a broad lawn on a Belgian estate. *Lower right:* Bay trees (*Laurus nobilis*) are trained with spiral trunks for use in public places. These are at the nursery of Sanders et Fils, Bruges.

DENMARK

In Knuthenborg Park is a forest of 120-year-old European beech trees (*Fagus sylvatica*)

Swan Lake and naturalized daffodils at Knuthenborg.

Knuthenborg Park

AT the 1,000-acre park of Count Ferdinand M. Knuth at Bandholm, native plants that have been scrupulously preserved are harmoniously blended with appropriate trees, shrubs, and wild flowers from other countries, some of which—rhododendrons, daffodils, and oxlips notably—have become naturalized. Some magnificent English oaks have been on the property since 1600.

Development of this fine private park continues steadily. Japanese cherry trees planted recently are expected in a few years to rival those in Washington, D. C., or at the Brooklyn Botanic Garden.

In addition, Count Knuth takes part in the testing of foreign fruit trees to find new varieties suitable for Danish culture. Apples are a specialty. A large collection of cacti is maintained under glass.

For a small charge the owner opens his estate to visitors, but only "as a quiet, peaceful area where nature lovers can come and enjoy restful hours among trees, flowers, and wildlife. The use of radios and phonographs is discouraged. . . There are no other entertainments—just peace, beauty, and open spaces."

The King's Park in Copenhagen.

Typical scene in the Danish countryside.

Lupines of many colors bloom outside a thatch roofed cottage near Copenhagen.

FINLAND

Gardens in front of public buildings, as at the Turku railway station, above, have always been the custom in Finland. When new apartments and other buildings are erected, every possible tree is left standing in the vicinity, and a landscaped garden is often created up to the very door—sometimes to the exclusion of a service road. To a nation of nature-lovers, such as the Finns are, a natural-looking scene may be more essential than the convenience of some man-made structures.

Summer residence of the Finnish President at Naantali, on the southwestern coast.

FRANCE

Château gardens in the North, subtropical plantings along Riviera, claim attention

FRANCE is divided into two quite definite climatic zones for gardens: the northern area and the Mediterranean region of the French Riviera. The northern region one invariably associates with the great parks of the châteaux, the famous gardens of Le Nôrte at Versailles near Paris epitomizing their style. The outstanding garden of the château country along the Loire River, southwest of Paris, is at Villandry. Many other château gardens and parks are open to visitors in an area easily reached from Paris.

Among the châteaux with outstanding gardens may be mentioned the following:

Jardin Kahn, St. Cloud-Sur-Seine, Bois de Boulogne, Paris. A kind of museum of gardens. There is a Japanese tea garden with 300 bonsai trees; an espaliered fruit orchard *par excellence;* and a simulated Vosges mountain forest.

Chenonceau, near Tours. A Renaissance château with grounds covering about 800 acres.

Azay-le-Rideau, at Chinon on the Indre. A 16th-century château of nearly 2,000 acres.

Menars, 8 kilometers from Blois. An 18th-century château associated with Madame de Pompadour. Flower beds, fountains, an orangery, and a park.

France preserves a rich legacy of gardens of the classical and baroque periods. Present-day gardens are less pretentious and are influenced more by the English flower garden and by 20th-century concepts of design. Some of the best of modern French garden architecture may be seen around new public buildings and private dwellings.

The typical French garden is more often developed as a thing of the spirit

One aspect of French taste in garden design is revealed in this geometrical layout.

Gardens at Montpellier have recently been restored. Above is the 18th-century orangery.

than for the plants it contains. It is not considered as a collection of plants, but rather a creation for the soul. A long row of trees, a green sweep of grass, a statue, a bouquet of flowers, becomes a way of life in a manner not fully appreciated on the western side of the Atlantic. The Italian influence in the garden art of northern France is well marked and has suited the French taste since this style was introduced in the 17th century.

Planting of trees is important to every Frenchman. One sees this in evidence all over France in the mile after mile of tree-lined roadways. The long avennes of plane trees, Lombardy poplars, and cottonwoods exemplify the feeling one finds also in French gardens.

The French Riviera extends along the Mediterranean coast from Hyères to Menton at the Italian border, about 200 miles. The many subtropical gardens of this warm coastal area are unrivaled in southern Europe.

Roses and carnations are grown outdoors here by the million for the northern French market. Around Grasse, slightly inland, fields of flowers for the perfume industry are spectacular and fragrant.

Among the private estates of special interest on the Riviera are these:

Serre de la Madone, Menton. Rare plants from China, Burma, Africa, and other distant places.

La Léonina, Beaulieu-sur-Mer. Collections of herbs, drug plants, and other economic species; also specimen trees.

Villa Casa Rossa, Menton-Garavan. An expanding garden and house in typical Provencal style in the mildest part of the Riviera.

Botanic Garden, Montpellier

The Jardin des Plantes at Montpellier, administered by the university, is the sixth oldest botanical garden in the world. This was a place for scholars of natural history to study plants during the Renaissance period. In this famous old garden the great Pierre Magnol taught botany in the 17th century and later the distinguished Swedish naturalist, Carl Linnaeus, honored Magnol in the plant we all know as *Magnolia.*

The present Montpellier garden covers 50 to 75 acres, and in the Mediterranean climate it is possible to cultivate a wide selection of warm-temperate plants. The cold winds of the mistral, however, prevent growing all but two or three of the hardiest palms.

An 18th-century orangery and a series of conservatories for tropical plants are features of the garden. Also, there is an outstanding rock garden containing native plants of the Mediterranean area. All plants are clearly labeled. A new botanical institute, when completed there,

The Queen's House on the palace grounds at Versailles faces a rustic pond. Wisteria i growing on the pillars that support the long balcony.

will be the largest center for botanical research in France.

The garden is open to visitors daily without charge.

Versailles

The gardens of Versailles, about half an hour's ride from Paris, are among the best known of the western world. Patterned after the great Renaissance gardens of Italy, they were first made famous through the genius of André Le Nôtre builder of the gardens for Louis XIV, i the 17th century. Altogether the garden cover several hundred acres. They hav been reconstructed at least four time since the 17th century, each time with onl slight changes and always with considera tion for the original conception of L Nôtre. Long avenues of trees, gree vistas, and much statuary typify th earlier Versailles. The great flower bed

seen in the garden today are a later embellishment, styled after the 18th-century English flower garden.

The grounds and gardens of the château are open to the public most days. A small entrance fee is charged.

Arboretum des Barres

As a national forestry school and arboretum the 700 acres of the Arboretum des Barres contains the largest collection of temperate woody trees in the country. It is located in the gently rolling landscape of Loiret, about 3 miles southeast of Nogent-sur-Vernisson and about 90 miles south of Paris.

The gardens were first laid out in 1821 by Philippe-André de Vilmorin of the famous horticultural firm. Magnificent conifers are an outstanding feature there. Several California redwoods (*Sequoia sempervirens*) planted nearly 100 years ago, are now 120 feet tall and nearly 3

Sculpture is ever in view at Versailles, forming an unending pattern with flower beds, water, hedges, and trees.

Water plays a decorative rôle in the rose garden of the firm of Georges Truffaut in the town of Versailles.

Against the ancient base of the château at Angers, where there was once a moat, elaborate parterres have been planted. Angers is on the main road from Tours to Nantes.

feet in diameter at the base. There is a young forest of the big-trees of California (*Sequoiadendron giganteum*) averaging 20 to 30 feet in height and growing rapidly. Rare kinds of fir, pine, and spruce from the Orient are among the choice trees in the collections.

The grounds are normally open to the public without charge.

Les Cèdres

The 100-acre garden of Monsieur Julian Marnier-Lapostolle on Cap Ferrat, known as Les Cèdres, is prominent among the newer gardens of the French Riviera. Bounded on three sides by the Mediterranean, a few miles east of Nice, the garden enjoys a favored site in "La Petite Afrique" section of the southern French coast. Nearby, the Maritime Alps rise for several thousand feet almost vertically from the sea and effectively shield the coastal region for many miles against cold northerly winds. Frost is therefore rare. Climatically, the garden is admirably situated for growing warm-climate plants.

Orange colored hybrid gazanias from South Africa border this walk beneath the date palms at Les Cèdres. This many-faceted Mediterranean garden is open for botanical research.

Cypresses border the long *allée d'eau* looking toward the mountains at Les Cèdres. Cyclamens are blooming in the foreground.

The collections contain about 10,000 species and varieties. The assortment of succulents alone is one of the largest in Europe. There is a tropical jungle complete with bananas, palms, begonias, lianas, and numerous other ornamental species that are associated with the rain-forests of the tropics.

Although the garden is private, Mr. Marnier is willing and happy to admit serious-minded plantsmen to his garden, since his place is designated as a botanical garden for the use of education and research.

The Bagatelle rose garden, at one edge of the Bois de Boulogne, is a favorite spot for early summer visitors to Paris. It is an international rose test garden.

At the Roseraie de l'Hay, about 10 miles south of Paris, there is one of the world's finest collections of old-fashioned roses. The garden is open for a small fee.

The Château of Villandry dates from the early 16th century. The designs made with closely clipped boxwood, shown in the lower picture, symbolize various aspects of love. The topiary trees are *Taxus baccata.* The tub-grown orange trees are stored in winter in the cavelike orangery, with arched doors, at the right. The gardens were restored to their original design around 1910 by the father of the present owner, François Carvalho.

If there is a spiritual link across Italy between Attic Greece and the Spain of Philip IV, it is at Les Colombières, created by Ferdinand Bac, at Menton in the Maritime Alps. Here black cypresses, silvery-leaved olives, laurel of Apollo, myrtle, and twisted carob dominate a scene authentically Mediterranean that would breathe memories of pagan charms and the Greece of long ago. Plants from other lands are banned from this garden.

Closer to Paris than the château country of the Loire, Vaux-le-Vicomte, near Melun, has characteristic vistas and formal green gardens of yew and box.

Informal borders, north and south, are shown in these two scenes. In contrast to the geometric greenery of most château gardens, the Château de Clères, near Rouen, has colorful beds of flowers. *Below:* At the Villa Roquebrune, on the French Riviera, there is a typical Mediterranean garden on the cliff above the sea. The evergreens in the background are cypresses (*Cupressus sempervirens*) and Aleppo pines (*Pinus halepensis*). Prominent among the flowering plants are many geraniums (*Pelargonium*), *Felicea amelloides* with delicate blue flowers, yellow *Centaurea ragusina*, and *Erigeron karwinskianus* from Mexico, now widely naturalized among the rocks of this entire coastline.

Lou Soueil at Eze, high above the Mediterranean near Menton, carries out the familiar French pattern of clipped box and cypresses.

Large palms of the hardiest kinds are a feature of Villa Thuret, the National Institute for Agronomic Research at Cap d'Antibes (one of the leading horticultural institutions of France). The collections contain nearly 2,000 kinds of plants, mostly Mediterranean and other subtropical species. The grounds are usually open to the public.

Flower Fields and Terraces

Few sights and smells are comparable to those produced by the flower fields and terraces of southern France. Many kinds of fragrant flowers are grown outdoors here for their essential oils.

At Grasse, mainly jasmine, roses, violets, lavender, narcissus, bitter orange, and acacia are cultivated. Picking of the flowers is entirely a hand operation. Of jasmine, several hundred thousand flowers are required to produce one ounce of concentrated essence, worth several hundred dollars.

Most of the flower fields are small and may be easily visited. Beginning in February with acacia and narcissi there is a continuous display, ending with jasmine and lavender in midsummer.

The geography of this general region is such that many plantings must be made on terraces supported by dry stone walls. From Antibes to Menton, oranges and pinks are grown on the nearly vertical mountainside. Elsewhere, anthemis, stock, calendula, and mignonette are grown on terraces for the products of their flowers.

Stone walls support the terraces on this rocky mountainside near Grasse where oranges are grown for the use of their scented flowers in the perfume industry.

Carnation culture is on terraces where mountains meet the sea on the Côte d'Azur.

Jasmine flowers are gathered by hand from planted fields in the Maritime Alps.

GERMANY

City planners and home gardeners benefit from big national horticultural exhibitions

HORTICULTURE and gardening are reflecting the aura of prosperity seen in the Germany of today. Since World War II, there have been seven major federal horticultural exhibitions. These great fairs run for six months each in odd-numbered years, and usually cover about 100 acres of ground. The Dortmund exhibition of 1959 attracted over 7,000,000 visitors.

Germany also has a thriving nursery industry, mostly in the northern part of the country. Some 2,000 firms are located there.

Modern gardens of Germany often are like those of our own country, and the axiom seems to be that every new house requires enough space for a flower garden. German people feature color in their plantings.

Parks are well filled with large beds of gay summer flowers. In spring the bulb displays are among the best in Europe.

City planning since World War II is amazing. Modern towns, always with parks and gardens, have arisen from bombed-out areas. The rebuilt Tiergarten (which is a park, not a zoo, as its German name indicates) is a splendid example of Berlin's efforts at recreational rehabilitation.

The people's respect for public property is such that one never sees "verboten" signs in German parks. Lawns are accepted as places of beauty, not to be tread upon.

Indoor gardening is much practiced, great interest being shown in succulents, especially cacti. Pride in collections of house plants is a prominent feature of living in the new Germany.

Meanwhile, numerous old parks, some established more than 200 years ago, still rank among the best in Europe. Such old gardens occur at Hanover and in the castle parks at Ludwigsburg, Veitshöchheim, Wilhelmshöhe near Kassel, and Sanssouci near Berlin (now in the Soviet Zone). The great English Garden and the Hofgarten, both in Munich, are also noteworthy.

Gruga Park in Essen is the scene of the fifth great National Horticultural Exhibition of West Germany (May to October, 1963).

The German "Kleingarten"

For people living in large cities and industrial areas, the German "Kleingarten" movement satisfied the native desire to cultivate the soil. The municipalities provide the land, usually on the edge of the city, and apportion lots, about ⅛ to ¼ of an acre in size. The aim is to provide gardening space for city dwellers who would not otherwise be able to cultivate their own vegetables and flowers.

The Kleingarten tenant always erects a small house for use on week-ends. Indeed, the Kleingarten is treated very much

like the week-end cabin at the beach in the United States. Dortmund alone has 70 Kleingarten-parks, each with 50 to 100 week-end residents. Competitions are held between cities and the Golden Harvest Crown is awarded the winner.

Berlin-Dahlem Botanic Garden

Characteristic plants of some of the world's varied geographic divisions, mainly in the northern hemisphere, form the largest and one of the most attractive outdoor features of Berlin's Botanic Garden in Dahlem. The sections devoted to the Pyrenees and other mountainous areas, including the North American Rockies, are particularly impressive.

Ponds and lakes are located throughout the grounds of about 90 acres. The arboretum, which came through World War II with very little damage, contains an outstanding collection of trees, arranged systematically, according to plant relationships, yet it appears like a park. Other outdoor collections include economic and medicinal plants, water and swamp plants, morphological and biological groupings, and decorative plants, besides a garden in Italian style in front of the greenhouses. The palm greenhouse alone covers 8,500 square meters and is 33 meters high. There is a special house for the royal waterlily (*Victoria amazonica,* also known as *Victoria regia*). Other houses contain large collections of cacti and other subtropical and tropical plants.

Other Botanic Gardens

Germany has long recognized the value of botanic gardens to the people. Nearly every city deserving of the name and, similarly, every university has one. A recent list names 57. Those considered especially worth visiting, besides Berlin-Dahlem, Bremen, Munich-Nymphenburg, and the Frankfort Palm Garden, are in Darmstadt, Dortmund, Essen, Hamburg, and Kiel. In addition, the Universities of Bonn, Frankfort, Göttingen, Heidelberg, Cologne, and Mainz have noteworthy collections of cultivated plants. At Weihenstephan, near Munich, the horticultural college maintains extensive trial grounds for herbaceous plants.

Rebuilding goes on apace at the world-renowned Berlin-Dahlem Botanic Garden.

Munich-Nymphenburg

Rare new plants in a sunken area called the Jewel Court (Schmuckhof) greet the visitor just inside the entrance to Nymphenburg, the botanic garden of Munich. Not far behind this is the arboretum with an extensive heath garden nearby.

The alpinum, near a pond, is divided into geographical areas by continents. A fern glen leads to a rhododendron forest that is shaded by pines and larches 120 years old. From here, the visitor enters an area of economic and medicinal plants arranged by families.

Extensive greenhouses, as well as the entire grounds, are open to the public every day of the year, from 9 to 7 except in winter when the grounds are closed at 5 P.M. There is a small admission charge.

On Mount Schachen, above Garmisch-Partenkirchen in the Wetterstein Mountains, there is a remarkable rock garden under the management of the Nymphenburg garden. Here 2,000 plants from all over the world are grown in an arrangement corresponding to the area of their origin. Open from mid-July until mid-September for a small fee, this garden may be reached from Garmisch, Klais, or Mittenwald after four or five hours on foot.

A long climb takes one to the alpine garden in the mountains above Garmisch.

The heather garden shown here is in the Munich Botanic Garden at Nymphenburg.

Cacti and waterlilies, including the platter-lily of the Amazon (*Victoria amazonica*, also known as *Victoria regia*) are among the greenhouse displays at Nymphenburg.

In the Ruhr industrial district, keeping green spaces green presents many problems. At Gelsenkirchen, as in many factory towns in Germany, the well-kept woodlands and parks successfully mask many of the steel works and factories.

Bremen Botanic Garden, Rhododendron Park

When the German Rhododendron Society was founded in 1935, it decided to develop the existing Rhododendron Park in Bremen into a major botanic garden. One of its aims was to show people how to lay out a garden; another was to serve the professionals in horticulture, especially in methods of propagation. Today these combined gardens are visited by 200,000 persons a year.

In the botanic garden there are, in addition to ornamental plants and vegetable gardens of interest to the home grower, sections devoted to medicinal and economic plants, native species, rock garden plants, and groups showing systematic, biological, and geographical arrangements. Among the ornamentals are a collection of annuals, also plants for shaded situations. In all some 6,500 varieties are grown, with 950 additional kinds in the Rhododendron Park adjacent.

Experimental work with growth hormones is carried out at the botanic garden in collaboration with the Institute of Botany of the technical high school of Hanover.

The Rhododendron Park in Bremen was the genesis of the botanic garden there.

Palms under glass simulate a tropical forest in Frankfort's famous Palm Garden.

Palm Garden at Frankfort on the Main

From a small planting begun in 1869 by the citizens of Frankfort (Frankfurt) through their Palm Garden Society, the Palmengarten has grown into a major botanic garden and park of about 45 acres. Tropical and subtropical as well as temperate plants are arranged by regions. Frequent flower shows are staged to show the public the newest and best that horticulture can offer. While the garden serves the public primarily, the plant collections are also used by the students at the University of Frankfort. The city sponsors concerts and sports events at the Palmengarten.

Hobbie's Rhododendron Garden

An important rhododendron garden can be visited at Linswege, near Westerstede in Oldenburg, where Dietrich Hobbie has developed, over the past 20 years, an excellent new race of dwarf hybrids. *Rhododendron repens* and *R. williamsianum* are the principal parents. The best of the named seedlings are compact plants, two to four feet in height, with bell-shaped flowers ranging from scarlet to pink. The plantings are spread over several acres of Scots pine woodland.

One of the most elaborate of the 18th-century German parks was Wilhelmshöhe, on the hills of Kassel. Beautifully kept lawns and fine trees are its main features today. The fastigiate English oaks to be seen there are the largest of their kind in Europe. The taller one, *top right*, 200 years old, stands 125 feet high.

The Castle Park of Benrath has millions of tulips in spring. Düsseldorf boasts 2,000 acres of green open spaces.

As viewed from the air, the Great Garden of Hanover (Hannover) reveals an elaborate geometric layout. This planting was started in 1666. Hedges in the open air theater (*lower left*) were installed in 1698. The fountain, shooting up 206 feet, is the highest in Europe. The four parterre gardens with light backgrounds in the center depict the history of gardening from the Renaissance through the 18th century. Colored sand and gravel contribute to the design.

Contemporary gardens in Germany. *Above*: An intimate garden containing many colorful plants. *Below*: A garden designed by Hermann Mattern.

The outdoor flower show remaining from the 1959 National Horticultural Exhibition in Dortmund presents seasonal plantings in beds like small home gardens. An important new horticultural attraction thus is added to this industrial city of the Ruhr.

Garden Shows (Bundesgartenschauen)

Gerd Krüssmann

Federal Horticultural Exhibitions that have been held every two years in various cities of Western Germany since World War II are the largest ever attempted in this country. These colossal shows are a scheme to promote German horticulture at the level of the average home gardener. Running from May 1 to October 31 in odd-numbered years, they require two years to prepare. The local municipality underwrites the entire cost, which runs into millions of dollars, under the auspices of the Central Association of German Horticulture.

The shows are held on about 100 acres of relatively undeveloped ground, the object being to establish the area as a permanent garden of the municipality. The exhibitors consist largely of nurserymen, who contribute all materials. At the end of the show the municipality purchases materials desired for the permanent plantings.

Every aspect of the horticultural trade is represented, including the latest ideas in garden design, with many gardens built fully to scale. The theme of color with flowers is uppermost in the over-all planning. Rose gardens, rock gardens, heath gardens, and an extensive exhibit of "little gardens" (Kleingärten) are represented. Cemetery landscaping is featured at some of the shows. New garden machinery, greenhouses, horticultural sundries, and a comprehensive horticultural book section are prominent commercial aspects of the exhibitions.

Popularity of these shows is evidenced by the 1959 exhibition at Dortmund, which attracted seven million paid admissions at about fifty cents each. This is a city of over a half million persons. Stuttgart acts as host to the 1961 exhibitions; Essen in 1963. These are garden shows *par excellence*, unlike any yet attempted in the United States.

Many cities of Germany hold annual garden shows, very much as we find in the larger American cities as a prelude

to spring. Dortmund, for example, annually holds a spring show for ten days in March. As many as 3,000 rhododendrons up to six feet tall may be included in this popular exhibition.

From April to October, 1960, a Franco German Horticultural Exposition is being held in Saarbrücken as "A contribution toward better understanding in the 'Shopwindow of Two Nations'."

The flowering of *Magnolia soulangeana* initiates spring on Mainau. While many temperate zone plants thrive here, as on the mainland, the moderate climate permits subtropical plants to grow in the island's gardens.

The rice-paper plant of the Orient (*Tetrapanax papyriferus*) grows on the island of Mainau as spectacularly as on its native island of Formosa. Also to be seen here is the sequoia (*Sequoiadendron giganteum*) of California.

Isle of Mainau

On an island called Mainau in the German part of Lake Constance (Bodensee), the garden of Count Lennart Bernadotte, nephew of the Swedish king, ranks among the gems of European horticulture. On this small island it is possible to grow palms and a hardy Japanese species of banana out-of-doors, so mild is the climate this far north in middle Europe. The old park laid out in the 18th century by a German Duke of Baden is noteworthy for the large trees that form the basis for the design of the modern garden. The present Count Bernadotte has successfully transformed the property into one of the truly noble gardens of Europe. From early spring when the flowering bulbs begin, the garden features a wide variety of massed floral effects throughout the summer until autumn. These displays are effectively spread across lawns that border magnificent woodland plants with vistas of the lake at several places.

Though a private garden, this is open to the public daily from 7 in the morning until dark.

ITALY

Renaissance design, also botanic gardens, had their origins here

CLIPPED boxwood hedges, topiary work, fountains, and statuary form the elements of the classical Italian garden. The Renaissance designs of the 15th century, which were based on classical Roman, are still much in evidence in Italy. Similarly dominating the garden scene are the ornate baroque styles of the 16th to 18th centuries, as seen in parts of the famous Boboli Garden in Florence.

The classical Italian garden was an ostentatious creation as befitted the taste of the period. Laid out with geometric precision, the grounds were designed primarily as outdoor living rooms, largely to accommodate great festive gatherings. The only flower gardens of the day were in the botanic gardens of the universities.

Italy, in fact, is the mother of botanic gardens. At Padua, where it was founded in 1545, is the world's oldest botanic garden that has remained on its original site. It is still an interesting and beautiful garden to visit. Other botanic gardens of antiquity and renown are at Pisa, Florence, and Bologna, with the 18th-century gardens of Palermo and Modena and the later one at Genoa also being noteworthy. But botanic gardens are located in all the university towns of Italy. Unfortunately, no effort is made to popularize the botanic gardens. In academic language, they are institutions of learning, and as part of the university they are not opened as public gardens. But the visitor will find such places full of interesting plants and often very instructive in design. To visit these gardens, one must first make inquiry through the adjacent botanical institute.

One of the four 16th-century entrance gates to the Botanic Garden of Padua. The original circular stone wall, 15 feet high, still surrounds the garden. Some of the existing trees were planted in the 1500's.

Typical of Italian gardens are potted plants ranged along a balcony. In Venice, the balcony gardens, planted often with trailing vines, overhang the canals.

Small private plantings in Italy more often than not are located above street level, on balconies and roof-tops, where plants in surprising quantity are grown in ornamental terra cotta containers. It is not unusual in such potted gardens to find quite an array of small trees, rose bushes, bulbs, and irises. Container-growing is one of the most popular forms of gardening in modern Italy, for space often is a factor limiting the ground area for a garden.

Villa Taranto

The garden of the Villa Taranto on Lake Maggiore, between Pallanza and Intra, dates from 1930 when the present owner, Captain Neil McEacharn, moved to Italy from Scotland. Already it possesses the most comprehensive collection of temperate plants in southern Europe.

This is a pleasure garden with the scope of a botanic garden. While Captain McEacharn maintains a life interest in the Villa Taranto, the gardens are even-

Above: So unique is a lawn in Italy that children enjoy patting the grass at the Villa Taranto. *Below:* Water flows in a parallel series of curved cascades between flower beds in one part of Captain McEacharn's garden.

Above: The Chinese lotus (*Nelumbo speciosa*) is given a special pool at Villa Taranto. *Below:* Fountains play in a flower garden.

tually to become a gift to the Italian government as a legacy to the people of Italy. A school for horticulture is to be established there.

Part of the garden stands on a promontory nearly 300 feet above Lake Maggiore. Terraced water gardens are a novel architectural feature. A valley has been excavated to accommodate azaleas, lilies, hostas, daffodils, and other woodland plants. The collections are fully labeled. There is a large conservatory.

The garden is open to the public for a small charge from April to November. Guides that speak several languages are available for groups. A half day should be allowed for seeing the garden.

Milan is one hour away by auto. The railway station is Verbania-Pallanza, on the main line from Paris to Istanbul.

Isola Madre, largest of the Borromean islands, lies in Lake Maggiore, with the town of Pallanza on the nearest shore. Regular boat service connects the island with the mainland.

South American wine palms (*Jubaea spectabilis*) border walks on Isola Madre.

This Kashmir cypress (*Cupressus cashmeriana*) stands more than 60 feet high.

Entrance gate to the Villa Carlotta, near Tremezzo on the Lake of Como. When azaleas bloom in spring, the grounds become a show place.

Isola Madre

The equable climate of the Borromean Islands in Lake Maggiore permits the culture of warm-temperate plants and fosters their growth into specimens of outstanding size and beauty. On Isola Madre, largest of the four islands, Count Borromeo has rhododendrons with trunks nearly a foot in diameter at the base, enormous azaleas, and tall magnolias with branches sweeping the ground.

A Mexican pine, a Himalayan cypress, and several California redwoods stand over 100 feet high. Pines border the walks around the island, which is connected with Pallanza by boat service.

Myrtus luma, a beautiful Chilean tree of the myrtle family, is worth noting for its cinnamon-colored bark. Among other interesting evergreen plants there are the American anise (*Illicium floridanum*), from southern United States, and *Escallonia floribunda*, a South American saxifrage relative. The arboretum was planted 200 years ago.

Other Villas on the Italian Lakes

The International Dendrology Union in 1957 was privileged to visit the gardens of a score of villas in Italy's lake region and adjacent Switzerland. While not all of these are open to the public, they were of such interest as to be considered worthy of mention here. Inquiry at each place will determine which ones may be visited without advance arrangements.

Lake Como region *(Italy)*

Villa d'Este*, Cernobbio. A hotel, once the home of Queen Caroline of England. Fine avenue of cypress.

Villa Sola (owner, Count Sola). Perfect example of old style of Italian garden.

Villa Carlotta, Tremezzo (formerly home of Prince Saxe). Wonderful collection of old specimen azaleas and camellias.

Villa Margherita (owner, Dr. Giovanni Rodio), Cadenabbia.

Villa Maria (owner, Mr. Chr. Schmid), Cadenabbia.

Villa Guiseppina, Cadenabbia.

Lake Maggiore region *(Italy)*

Villa Elena (owner, Signor Dr. Nobili), Pallanza. Fine old garden by the lake with many specimen plants.

Villa San Remegio (owner, Marchese Della Valle di Casanova), near Pallanza. A garden designed in Italian style over 60 years ago by the Marchese, who came here from Ireland.

Isola Bella (owner, Prince Borromeo). An island garden in baroque style.

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*This is not the Villa d'Este that is at Tivoli, near Rome.

The municipal rose garden in Rome—Il Roseto all'Aventino—is a recent creation of Dr. Elvezio Ricci, Director of Parks. It is an international rose test garden.

Garden of Signor Edgardo Mosca, Biella. Collections of conifers, hollies, camellias, and many old specimen plants, including a honey locust reputedly 400 years old.

Alpine garden, Stresa. Native plants of the Alps are featured in a garden above the town, looking out over the water and mountains beyond.

Lake Lugano region ***(Switzerland)***

Civic Park and Lyceum (Liceo), Lugano.

Villa Maria (owner, Signor Giuseppe Paolini), Villa Soldati, and Villa Helios, all near Lugano.

Villa Favorita, Castagnola.

Lake Maggiore region ***(Switzerland)***

Garden of Mr. J. Fritsche, Minusio, near Locarno.

Garden of the Albergo (Inn) Brenscino, near Brissago.

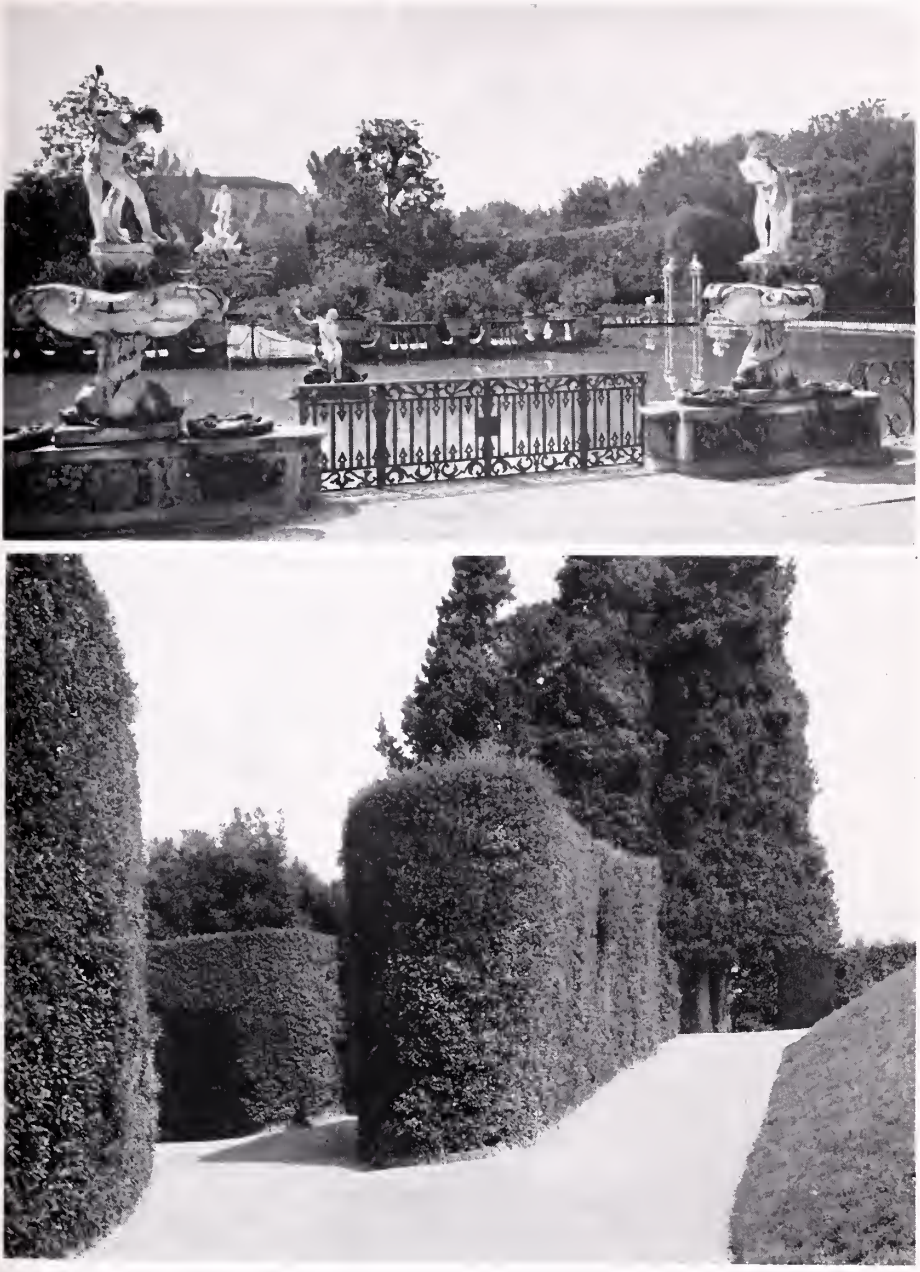
Villa Helvetia, near Brissago.

Gardens of Rome

For travelers who can read Italian there is a helpful and delightful book, "I Giardini di Roma," a large volume in paper covers prepared and published by the Department of Parks (Servicio Giardini) of Rome under the guidance of the director, Dr. Elvezio Ricci. A list shows that 16 of Rome's great villas dating back many centuries are still in existence today. Nine other villas built before 1800 continue to exist in part. There are 20 additional major parks in Rome and some 200 small parks and green spaces.

Rome's most celebrated garden place is probably the Villa Borghese, built in 1605. The plantings combine the formal effect of the needle-pointed cypresses and clipped box with the naturalness of Italian stone pines (*Pinus pinea*), pools, and broad tree-shaded lawns. Balearic Island box (*Buxus balearica*) is used exclusively here instead of the English type.

Among other gardens particularly mentioned by Dr. Ricci are the 15th century Villa Sciarra, oldest villa still in existence, where pleasant fountains spout beneath the trees; the Villa Celimontana of 1553, with palms and pine-shaded avenues; the Villa Aldobrandini, 1585, which has a splendid azalea display in spring; the Villa Corsini of 1732, from whose summit there is a fine view over the city; the Villa Paganini, with broad walks beneath tall umbrella pines; the Villa Mazzini, containing a formal pool; the Parco Virgiliano, which has an interesting rock garden; and Castelfusano, noted for its long avenue of pines. The Valle Murcia is renowned for its rose garden.



The Boboli Garden presents a historical view of Italian design. Above is seen the baroque aspect; below, the classical style which preceded it. The hedges are of English holly.

The Boboli Garden

The Boboli Garden in Florence represents, perhaps more than any other, the evolution of the Italian garden during the Renaissance and the baroque periods. Conceived by Cosimo I about 1550, this garden is seen today essentially in the design of the late 18th century. It is not

The ancient gardens of the peristyle at Pompeii have been authentically reconstructed in the original style. Only plants mentioned by Pliny and others of the period are grown in these gardens. It is interesting to note a similarity in the architecture of these gardens with that of the Renaissance gardens of old Italian villas.

a garden devoted entirely to statuary, broad graveled walks, and clipped boxwood as in many of the old Italian gardens. Statuary of the 16th and 17th centuries is used with restraint.

The garden spreads over several hundred acres of undulating terrain overlooking the city of Florence and the Tuscan hills beyond. Expansive terraced gardens with fountains are located near the famous amphitheater adjacent to the Pitti Palace. The magnificent avenue of towering 75-foot cypress trees (*Cupressus sempervirens*) leading away from the Isolotto (a bizarre example of baroque garden art) is the finest vista in the garden. Towering holly hedges 20 feet high are especially imposing.

Rock Garden, Villa Hruska

Over a period of 54 years, Dr. Arturo Hruska has developed an outstanding rock garden within sight of Lake Garda in the northern lake district, at Gardone Riviera. Originally a vineyard and olive orchard, the location is broken into a series of four terraces. Gigantic rock formations with pinnacles and crags rise nearly 50 feet above the level of the garden. Indeed, few locations are better provided with the natural products necessary to develop an alpine garden.

The site covers about two and a half acres, into which Dr. Hruska has brought together a now famous collection of alpine plants, especially of the Alps, Pyrenees, and mountains of Asia. The public is admitted upon payment of a small fee.

The classical gardens of the Villa Gamberaia at Settignano, near Florence, are among the most sumptuous of all the Tuscan villas. Located well up in the Tuscan Hills, the site commands a splendid view of the surrounding countryside. Since World War II, the villa and gardens have been restored to their former splendor. They include some excellent topiary work and an especially effective clipped cypress hedge. *Note:* Visitors wishing to see other famous old gardens of Tuscany may join a tour in Florence, which covers about twenty of the finest Tuscan villas and their gardens.

Columbus's three ships are depicted with plants in this Genoa park.

La Mortola

Famed is the garden of La Mortola of the Villa Hanbury, on the Italian Riviera about 3 miles from Ventimiglia. The present place dates from 1867, when Sir Thomas Hanbury, an English merchant who had made a fortune in the Far East, purchased the 14th-century Palazzo Orengo, once the estate of a noble Genoese family, with 100 acres adjoining it. Among Mediterranean gardens it stands today as a splendid monument to its founder.

Plantsmen know La Mortola not only for its large and varied plant collections, but also as an architectural gem of the gardener's art. Few private gardens in Europe have attained the breadth and scope of La Mortola. Special features include a fine collection of acacias, subtropical vines, a herb garden redolent of scents from plants with fragrant foliage, and many old trees, particularly conifers, both native and exotic. Most of the plants have labels.

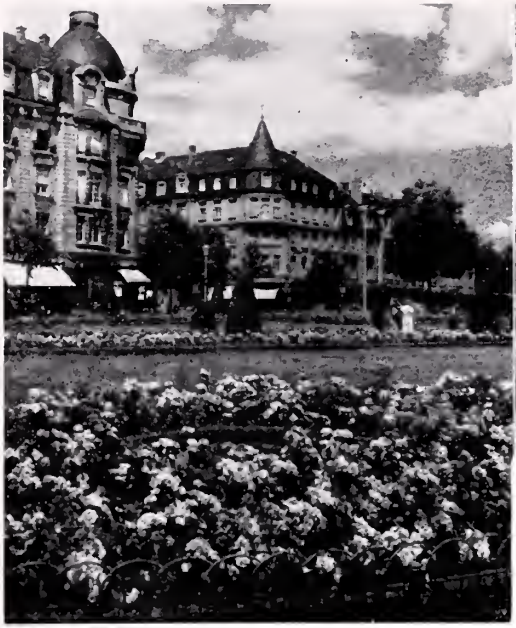
Left: A small temple at La Mortola. The sword-leaved tree in the background is *Yucca elephantipes.*

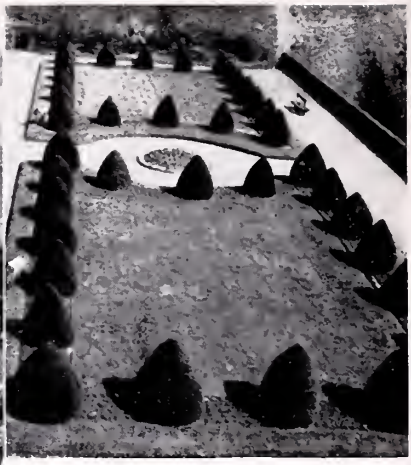
An ornamental fountain at La Mortola. Native pines rise among the cypresses.

A sturdy Canary Island palm stands beside the pink-stuccoed villa.

At Tivoli, tall Italian cypresses frame a view from the Villa d'Este across the plains to the distant mountains.

LUXEMBOURG





The Square of the Martyrs is the principal park of the capital city of Luxembourg. Besides such formal plantings as are shown above, the park is massed in season with polyantha roses, seen at the left.

Plants such as can be grown in the region of Washington, D. C., are cultivated in home gardens of the Grand Duchy of Luxembourg.

At the Jardin Exotique in Monaco, cacti thrive on the rocky mountainside. Here, opuntias show through iron grillwork.

Le Jardin Exotique—Monaco's Exotic Garden

Louis Vatrican

ON a steep cliff in Monaco, tiny principality on the Côte d'Azur, ringed by high mountains and the Mediterranean Sea, there grows an exotic garden that is perhaps the most original in the world. Here, at 44° 44′—a latitude close to that of Halifax, Minneapolis, and Portland, Maine—Europe's most important collection of succulent plants grows and blooms in the open air all the year 'round. Some of the cacti stand eight meters tall and the cactuslike euphorbias 12 meters. The garden is situated on a steep cliff almost devoid of earth and water. Every path has had to be carved through rocks or around them.

The Jardin Exotique was inaugurated in 1933 by Prince Louis d'Or, but it was his father Prince Albert I who inspired it. While examining construction work for the oceanographic museum, Prince Albert noticed the succulent plants that the head gardener had been cultivating for many years. He became interested not only in developing this collection but in finding a background suitable for its display.

In the crevices of rocks where the garden grows today, a more or less spontaneous vegetation of succulent plants had developed. Their presence indicated that physical conditions were favorable.

Work was begun on the garden in 1913, and it continued until 1933. As quickly as one area could be brought into shape it was planted. It soon became evident that the plants flourished exceptionally well on their precarious cliff location.

Monaco is surrounded by high mountains from the northwest to the east, and these mountains screen it against the cold alpine winds. The sea, on its side, further tempers the atmosphere.

The slope of the garden being at an angle of 45°, the sun in winter is approximately perpendicular, while at the summer solstice some of its rays are reflected enough to prevent excessive heat. Warmed by the sun during the day, the rocks store heat against the cold of the night; thus abrupt lowering of the temperature is avoided. The cliff induces condensation of moisture from the sea and this keeps the relative humidity at approximately 80 per cent, a condition favorable for succulent plants. Finally, the winters in Monaco are relatively dry, while the rains —especially in the autumn and spring—share the stormy disposition of those in the homelands of many of such exotics. These factors explain why Monaco can have an outdoor garden all year long of plants that are extremely sensitive to cold.

Every effort has been made to provide each rare plant with the growing condi-

The Rock of Monaco, called the "Dog's Tooth," rises behind 20-foot specimens of cereus at the Jardin Exotique.

tions of its natural environment. Yet in a skillful way the most colorful and curious kinds have been artfully blended to bring pleasure to the visitor. The work of propagation and acclimatization of some 6,000 species is not conducted in the scenic garden, but in a special nursery nearby.

The succulent groups most largely represented are in the cactus, euphorbia, aloe, amaryllis, crassula, carpetweed, and milkweed families. But among other families —notably the portulaca, grape, composite, and cucumber—there are species of succulent character that are also in the garden's collection.

Prince Albert's goal in creating the Jardin Exotique was to make these rare plants known to the public and to amateur gardeners. In addition, he wanted to make the collection the most complete of any in the world so that scientists from many lands would come to Monaco to study these plant curiosities.

Monaco's unique garden of succulents is open every day for a small admission fee. This charge includes the right to visit the Museum of Anthropology and the grottoes which open into the garden through a cavern where Cro-Magnon men lived some 30,000 years ago. The complete tour requires about two hours.

In the famous Gardens of Monte Carlo, created by Edouard André, subtropical trees frame beds of colorful flowers in a park facing the casino. An adjacent area is landscaped in the English tradition. Palms, figs, cacti, and laurel have attained gigantic height here; *Victoria cruziana* ornaments the pool.

NETHERLANDS

Leading attraction for garden-minded visitors are the acres of commercial flower fields

AS a national industry, the cultivation of plants is of greater importance now in the Netherlands than at any other time in the country's long horticultural history. Commercial horticulture today brings in 10 per cent of the income.

The three most important horticultural crops are bulbs, grown around Haarlem and Lisse, nursery stock centered in Boskoop, and cut flowers, around Aalsmeer. Each of these localities offers unique and marvelous sights to the visitor. The bulb and cut-flower fields, especially, present vast tapestries of vivid color. The great Dutch flower shows are also an unforgettable sight.

Great private parks such as one sees in other countries of Europe are rare in the Netherlands—practically nonexistent. The pressure of space is a challenge for gardeners in this country. Many plantings are small, compact, and precise. Around Bilthoven near Utrecht, however, there are some charming thatched-roofed country homes with flower gardens. Also at Hilversum—a town noted for its modern architecture with simultaneously designed grounds—there are gardens that blend attractively with houses and buildings.

Interest in house plants is highly developed in the Netherlands, perhaps as a solution for the space problem. A casual walk down many residential streets can be rewarding for the great variety of plants one sees on inside window sills.

Street trees are infinitely more varied than in American towns, and often specially developed forms with strongly ascending branches will be seen. Maple, ash, poplar, willow, elm, and hornbeam are among those most frequently used.

In all public places in the Netherlands marked attention is given to planting. Gardens everywhere are neat.

At Keukenhof, in Lisse, the finest of Holland's tulips, hyacinths, and narcissi are displayed amid natural scenery from early March until mid-May. During this period the 60-acre park is open daily for an entrance fee; the rest of the year it is closed. The park is owned and operated by a foundation composed of leaders in the bulb industry.

Arboretum Trompenburg

J. R. P. van Hoey Smith

Sheltered by the dike along the River Maas at Rotterdam lies the Trompenburg Aboretum, a small green sanctuary only a few yards from the grounds where in mediæval times proud Honingen castle lifted its towers skyward. The large trees of the arboretum create an oasis that effectively shuts out all the noise of the metropolis.

Trompenburg, named after the former country-seat called Trompenburg, lies on historical ground. The central plot of the area, dating from 1820, is laid out in English style. A number of oaks and two magnificent purple beeches planted closely together are all that remain of this oldest part of the plantation.

The present arboretum covers about 10 acres, and the collection contains about 1,000 kinds of trees and shrubs hardy in this climate. These include 80 different oaks (*Quercus*), 15 kinds of beech (*Fagus*), 22 pines (*Pinus*), 40 spruces (*Picea*), 43 junipers (*Juniperus*), 18 yews (*Taxus*), 62 false-cypresses (*Chamaecyparis*), and 20 kinds of arborvitae (*Thuja*). The cedar-tree (*Cedrus*) collection, however, is the pride of Trompenburg, with the Atlas, Lebanon, and Himalayan species gloriously represented in different forms.

The western part of the arboretum, originally meadow, was designed about 1870 by the well-known landscape gardener Zocher, architect for the main parks of Rotterdam. Several large ash trees, maples, a beautiful yew, and a bald cypress with knees remain from the design

Conifers of many kinds and sizes are to be seen at the Arboretum Trompenburg.

of Zocher. A large specimen of *Thuja plicata,* the giant arborvitae of western North America, also remains from this period. Recent plantings of the American river birch (*Betula nigra*) have grown rapidly into large trees. At intervals, groups of rhododendrons add a touch of color where small ponds and a small brook evoke a rural atmosphere.

The pinetum adjacent to the western plot contains a large collection of conifers, several of which are rare sorts. Some are mother plants of kinds that are used in quantity by the nurserymen at Boskoop. An important function of the arboretum is the introduction into cultivation of new species and forms for the benefit of forestry and landscape gardening.

Trompenburg's eastern part is reserved for the nurseries, a hothouse for succulents, a rose garden, and a long avenue planted in 1900 to elms and other exotic trees. Two gigantic Canadian poplars, 150 years old, which are reputed to be Rotterdam's tallest trees, stand guard at the entrance to this lane.

The home of the author (owner of Trompenburg) faces a waterway bordered with daffodils in spring.

This trunk and lower branches are of Atlas cedar (*Cedrus atlantica*). The cedar-tree collection is the pride of Trompenburg.

About 1928 the destructive elm disease caused great damage to all the elms in this garden. This necessitated a complete reorganization of the plantings. The rather one-sided original assortment of trees was replaced by a varied collection in a harmonious new design. A long-cherished wish was thus fulfilled, making Trompenburg an arboretum that would play a prominent part as a dendrological and scientific center for the town of Rotterdam.

Editor's note: Several visits made to this fine garden during the summer of 1959 left the definite impression that this is the finest private arboretum in the Netherlands. The author of the article fails to mention a huge specimen of Pfitzer juniper in his garden which is by far the largest this writer has had the good fortune to see. It measures 105 feet in circumference, 25 feet across, and 9 to 10 feet in height, though the specimen is only 30 years old.—F.G.M.

Leiden Botanic Garden

Founded in 1587, the Hortus Botanicus of Leiden is the oldest botanic garden in the Netherlands. In 1594, Carolus Clusius became the first professor of the Hortus Botanicus. He was widely known for his writings, which included, in 1576, an important early treatise on the tulip. In this was published some of the western world's first pictures of the plant.

With an apothecary assistant, Clusius set out over 1,000 species and varieties of plants in the garden. One tree from the days of Clusius still exists, a goldenchain (*Laburnum anagyroides*), planted in 1601, that still flowers profusely every year in May near the entrance to the garden.

Trees more than 100 years old dominate the Leiden plantings. They include choice specimens of copper beach (1820); a pink hawthorn (1740); a male ginkgo (1785); a very large weeping beech (about 1830); an old persimmon (1737); a Caucasian wingnut (1818); a fernleaf beech (1818); and a Japanese pagoda tree (about 1850).

Conservatories in the garden are filled with interesting plants from many parts of the tropical world; a special house is devoted to the Amazon platter-lily, or royal waterlily (*Victoria amazonica*).

The garden is part of the University of Leiden and is kept open to the public throughout the year. It covers about five acres.

Cantonspark

Cantonspark, the Botanic Garden of the University of Utrecht, lies in a picturesque part of the Netherlands at Baarn near the country seat of the Queen. Founded as a private estate half a century ago, the garden came into the hands of the university for use as a botanic garden in 1920. It is an attractive garden with expansive stretches of lawn and some of the largest beech trees in the Netherlands. A large conservatory is filled with tropical plants, and several smaller greenhouses have superb displays of tropical foliage plants.

Planted in 1830, this weeping beech at Leiden is 200 feet around and 45 feet high.

Cantonspark, at Baarn, is the botanic garden for the University of Utrecht.

The botanic garden at Terwinselen, near Maastricht, was designed by J. Bergmans. It contains a fine rock garden.

Picea abies inversa is one of the choice conifers at Blijdenstein.

Pinetum Blijdenstein

The small, compact, and beautifully maintained Pinetum Blijdenstein at Hilversum undoubtedly ranks as one of the outstanding collections of conifers on the continent. Started in 1911 by Benjamin Willem Blijdenstein, the collection is now one of the most complete in Europe. Pines, spruces, cedars, junipers, arborvitaes, hemlocks, and firs are represented in a vast array of species and garden varieties, including weeping, columnar, spreading, prostrate, and dwarf forms. They are all superbly grown, and arranged with some thought for eye-appeal.

The garden is administered jointly by the municipality, the university, and the botanic garden of Amsterdam under the immediate and capable supervision of Mr. G. Bootsman. Gardeners and students are always welcome to this garden for serious study or for sheer enjoyment of the beauty of the conifers.

Other Public Gardens

Amsterdam: Botanic Garden. Established in 1682; about 3 acres. This garden is owned by the Municipal University of Amsterdam, and is devoted exclusively to collections of plants for teaching purposes. A great number of specimens are packed into a very small space. The foot-wide pink blooms of the *Victoria* waterlily attract many people to the greenhouse evenings in late summer. Famous in history, the garden in the 18th century attracted Linnaeus; then in the 20th century, Hugo de Vries, renowned for his work on the mutation theory. Admission is free throughout the year.

The Hague: Zuider Park. A municipal park established in 1930; about 400 acres. The large assemblage of trees hardy in this part of the Netherlands has been developed over the past thirty years on what had been sand dunes. The collection is chiefly the work of Mr. S. G. A. Doorenbos, director of parks for The Hague until his retirement a few years ago. Admission is free at all times.

Wageningen: Botanic Garden and Belmonte Arboretum. Established 1896; about 50 acres. Developed by government sponsorship under the Ministry of Agriculture. Largely devoted to trees and shrubs, although herbaceous plants and a rock garden are also included. Now perhaps the largest collection of woody plants in the Netherlands. Admission is free at all times.

Some Private Parks

Doorn: Gimborn Arboretum. Established in 1924; about 50 acres. A private arboretum with an outstanding collection of conifers (over 600 kinds), some of the

finest specimens of rare types to be seen anywhere. Visitors are admitted upon application to the owner, Mr. van Gimborn, at Doorn.

Oldenzaal: Arboretum Poort-Bulten. Established in 1910; about 15 acres. About 2,500 kinds of trees and shrubs are grown here. The pinetum, which is the oldest part of the garden, contains some excellent specimens. Visitors are welcome upon application to the owner, Mr. C. M. Gelderman.

Oldenzaal: Kalheupink Park. A beautifully kept semipublic park, containing many large exotic trees. A 30-foot umbrella pine (*Sciadopytis verticillata*) is the largest one in the Netherlands.

Putten: Arboretum Schovenhorst. Established in 1848; about 160 acres. An extensive private pinetum developed by the Oudemans family over three generations. Devoted entirely to conifers, especially trees being tested for forestry use. The best planting of its kind in the Netherlands. Visitors are welcome upon application to the owner, Dr. J. Th. Oudemans.

Boskoop Nurseries

The nursery area of Boskoop covers about 1,100 acres, one fifth of which is water. About 675 nurseries are in this area. Inch for inch, the intensity of culti-

In this street planting in the town of Boskoop, the American swamp-cypress (*Taxodium distichum*) is used effectively.

Canals beside the Boskoop nurseries are a source of humus; they also serve as "roads."

vation at Boskoop rivals that of a greenhouse. Ornamental trees and shrubs are produced here by the million, and the plants are shipped to 40 countries.

The nurseries are always surrounded by narrow canals used for transporting nursery stock to the nearest road. The canals are also a source of humus. Each summer they become covered with a thick carpet of water-fern (*Azolla*) and duckweed (*Lemna*), that make them look almost like lawns. Come autumn, this floating mat dies and sinks to the bottom to form a black muck. This is later scooped out and dried as humus for the nursery beds.

Thatched houses are common in Boskoop, and gardens are gay. The house above, trimmed in red, has a bed of scarlet sage in front and window boxes filled with geraniums. The small lawn extends to the edge of the canal, which is covered with duckweed.

Graded bulbs are marked and packed in wicker baskets for auction. *On opposite page:* Daffodils share honors with hyacinths and tulips as a leading Netherlands flower crop.

NORWAY

Above: Among Norway's fjords, spring brings blossoms to fruit trees while snow lingers on mountains. *Below:* Along Oslo's river, the Akerselva, spring welcomes visitors to parks.

PORTUGAL

Oporto region leads in camellia culture while Lisbon area displays subtropical gardens

PORTUGAL is abundantly supplied with gardens, large and small, and with horticultural institutions. Gardening is part of the Portuguese tradition.

In spring, few areas of western Europe can compare with northern Portugal. The coastal region is moist and nearly frost-free and the soil is relatively rich. The acidic soils are well suited for growing rhododendrons, azaleas, and camellias. The continent's oldest specimens of camellia are here, around Oporto (Pôrto).

The Lisbon area, to the south, enjoys a climate somewhat similar to that of Los Angeles, California. Points of major interest within the city include, besides a number of small, well-kept parks, three botanic gardens and the Estufa Fria in Edward VII Park.

About 25 miles west of Lisbon, at Sintra, the climate suddenly becomes considerably more moist. Subtropical plants grow to perfection. Two outstanding parks here are Monserrate and Pena, but the latter is not regularly open to visitors.

Besides the places illustrated here, parks and gardens worth a special visit in Portugal are these:

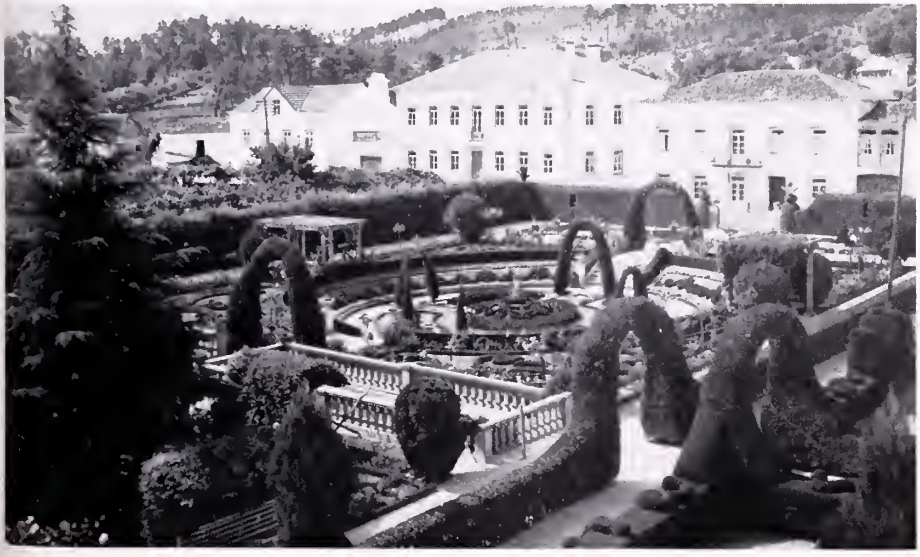
Oporto: Botanic Garden. An attractive garden built on the site of a private estate; a magnificent 20-foot camellia hedge and beech trees over 100 feet tall.

Oporto: Quinta da Meio. The finest English flower garden in Portugal, owned by Miss Muriel Tait. The largest tulip tree in Europe is here. The woodland is bright with naturalized sparaxis in March.

Lisbon: Botanical Park of Ajuda. A 100-acre arboretum and botanical garden of the Institute of Agronomy. Large collection of subtropical plants and many splendid specimens of Portuguese cypress.

Lisbon: Royal Park at Ajuda. Formal gardens with bright flowers planted within borders of clipped boxwood; also some unusual trees planted in the 17th century.

Lisbon-Balém: Colonial Garden. A botanic garden that is devoted primarily to studies of economic plants for the Portuguese colonies.



This elaborate formal garden is open to the public at Penacova.

Broad-topped plant at base of palms is the dragon tree (*Dracaena draco*). Behind it, is *Yucca elephantipes.* The tallest palm is *Phoenix canariensis;* the low feather palm, *Arecastum romanzoffianum.* Others are California fan palms (*Washingtonia filifera*), all in the Lisbon Botanic Garden.

Botanic Gardens

Portugal has two botanic gardens of importance, the Jardim Botânico at Lisbon, on one of the city's seven hills, and the garden at Coimbra, halfway between Lisbon and Oporto. The 50-acre Coimbra Botanic Garden, founded in 1772, is the largest and oldest in the country. It is rich in subtropical trees and palms, and it contains a bamboo forest. A formal sunken garden is a conspicuous architectural feature.

Tropical plants, including the giant platter-lily, or royal waterlily, from the Amazon, are grown under glass. The garden is well kept and offers a splendid opportunity to learn about tropical plants. All collections are labeled.

The Lisbon Botanic Garden, though administered by the university primarily as a study center, also contains much of interest to the layman. In a climate similar to that of Los Angeles, many subtropical plants, including an arboretum, flourish on its 12 acres. There is an impressive avenue of Washington fan palms and another of Canary Island date palms.

Both gardens are open daily without charge.

Children may practice gardening on their own small scale, as one of many activities in the "Children's Portugal." (For size of buildings, see the opposite page.)

The Children's Portugal

At Coimbra there is a kindergarten which is an entire city built on a child's scale. Complete with churches, homes, and a reproduction of the university, it also contains trees, pot-plants, and gardens, all in proper proportion for youngsters up to seven years. One corner is reserved for those who wish to do their own gardening.

Plants that are common in the Portuguese colonies are grown in another section, between houses built in native styles. Each house is a colonial museum.

Children of working mothers are cared for during the day in the "Children's Portugal." Visiting adults must pay an entrance fee.

Everything is built to a child's measure in this children's village in Coimbra.

The Estufa Fria, in Lisbon's Edward VII Park, is one of the more unusual horticultural attractions of southern Europe. This lath house "conservatory," which is without artificial heat, covers nearly two acres. With only this light protection, many tender tropical plants are grown for a jungle effect that otherwise could not be successfully achieved. The concrete pillars that support the lath covering are made to simulate tree trunks, and against these are planted clambering lianas. The more important plants are labeled. This is a municipal garden, open to the public for a small entrance fee.

Dona Filippa, Condessa de Campo Bello, stands beneath her camellia trees that are believed to have been planted at Villa Nova de Gaya in the 16th century. The trees have trunks 2 feet and more in diameter and stand up to 25 feet high.

Villa Nova de Gaya

The mammoth trees at the Villa Nova de Gaya in Oporto may well be the oldest specimens of *Camellia japonica* in cultivation in European gardens. The Conde de Campo Bello, present owner of the villa, presents evidence from the family archives that three living plants of the camellia were brought from Japan to Portugal to his garden about the middle of the 16th century.

The oldest trees are now about 30 inches in diameter at the base and about 30 feet tall at a reputed 400 years of age. The flowers are single rose-pink; they come into bloom in February and March. Camellias at Nova de Gaya are also featured in long hedges of 'Mathotiana,' a variety with 5-inch flowers. A horsechestnut tree (*Aesculus hippocastanum*) about 8 feet in diameter and a very old tulip tree (*Liriodendron tulipifera*) over 6 feet in diameter are among the other remarkable specimens here.

The garden is private, but the owners are willing to show their fine plants to visitors upon application.

Camellias form a dense hedge at Villa Nova de Gaya.

Quinta da Bacalhõa

Near the village of Villa Fresca de Azeitão on the main road south from Lisbon to Setúbal, the ancient gardens of the Quinta Palacio da Bacalhõa may be seen today much as they appeared in earlier centuries when the palace was the home of Portuguese royalty. This remarkable restoration has been brought about by a Connecticut woman, Mrs. Herbert Scoville.

When Mrs. Scoville bought the quinta in 1936, the palace was a desolate ruin. Roofs and floors had collapsed, columns and arches fallen, and broken tiles were heaped on the ground. During several years of patient work, Mrs. Scoville restored the little medieval palace, maintaining the exterior 15th-century design with historic accuracy and deftly modernizing the interior.

A tree-shaded lane leads from the main road to a gateway that opens on the large square forecourt of the quinta. On the west, below the loggia, is a boxwood garden of Moorish design, centered by a marble fountain. From here a wide path, lined with tiled containers for foliage plants and flowers, leads to a pyramidal-roofed pavilion containing five loggias walled with tiles. Facing this pavilion is an ornamental pool 100 feet square, supplied with water from the mouth of a stone dolphin ensconced in the garden wall.

The polychrome tiles, which are seen everywhere, are an interesting feature of Bacalhõa. They date chiefly from the 16th century and there are more than 30 different patterns—some geometrical, some typically Moorish, either with stylized leaves and flowers or forming pictures. The western loggia has five panels depicting rivers —the Nile, Euphrates, Danube, Douro, and Mondego.

Another path leads to a small stone building called the Casa de India because it was once decorated with painted cloth panels representing the four main Indian cities conquered by Albuquerque the Great. In another corner is a similar, but smaller, building which is used as a dovecote for white fantail pigeons. Four marble heads decorate the north façade of the house under the loggia. These seem to be portraits—perhaps of Princess Brites who built the palace about 1485, her father, mother and husband.

Tourists who wish to visit the gardens of the Quinta da Bacalhõa should write or telephone the owner a few days in advance. The interior of the palace is not shown.

Gardens of the Quinta da Bacalhõa have been restored to their original design.

Forest of Bussaco

As a "Monumento Nacional," the Forest of Bussaco is the oldest and most widely known forest preserve of Portugal. Planted originally in the 18th century by Carmelite monks who had founded a monastery on the site in 1268, the tract covers several thousand acres on the Serra de Bussaco, about 40 miles northeast of Coimbra.

In the old days the monks lived in small cells scattered through the forest, some of which still exist. A Papal Bull once prohibited women from entering the forest. Today, however, under government administration, there are no such restrictions. The forest is open to all visitors without charge.

Among the most lofty of the trees at Bussaco are 100-foot specimens of the "Portuguese" cypress, a tree important in Portuguese forestry both for fuel and fine cabinet work. Introduced from Mexico in the 16th century, this cypress today beautifies roads throughout the country.

There is an interesting tree-fern valley at Bussaco with many specimens 20 feet tall. In the same secluded area azaleas, rhododendrons, and camellias contribute to an admirable subtropical garden setting.

The remains of the ancient Carmelite monastery at Bussaco are now incorporated into a Manuellian style hotel, formerly a summer residence of the Portuguese kings and now the most élite hotel in Portugal. A series of formal gardens and a camellia garden are adjacent to the building.

Monserrate

In the Parque de Monserrate at Sintra, on the Portuguese coast west of Lisbon, there are plantings of subtropical trees that are unparalleled anywhere in Europe. The garden covers about 75 acres on a series of wooded ridges and deep valleys that are typical of the sharply undulating windward slopes of the Serra da Sintra.

One may see ponds, dells, flowering shrubs, tree ferns, and many kinds of trees on a drive through the 1,000-acre Forest of Bussaco in northern Portugal.

Rock-dwelling ferns are sprayed by a waterfall at Monserrate, Sintra, while tree ferns tower 20 feet above the forest floor.

Monserrate was developed about 100 years ago by Sir Francis Cook, a long-time British resident of Portugal.

Foggy summers, an evenly distributed rainfall throughout the year, and rare frosts favor the cultivation of tree ferns, palms, and many other plants that demand this combination of moisture and warmth. Norfolk Island pines here grow 120 feet tall. There is a tree-fern forest, also a palm grove.

The garden now is operated by the Portuguese government. The public is admitted upon payment of a small entrance fee. A full half-day should be allowed to see the garden adequately. Unfortunately, the plants are mostly unlabeled.

SPAIN

Moorish style of several fine historical gardens influences many contemporary plantings

THE kaleidoscopic history of Spain runs rich with artistic traditions that are always colorful. Along with appreciation of the arts—especially painting, music, and architecture—in which the intense feelings of the Spanish people are expressed is a recognition of fine gardening as part of the nation's artistic heritage. There is nothing in Europe to compare with the Moorish gardens of Granada. Gardens of the Spanish royal house built between the 16th and 18th centuries are today unequaled on the Continent. The Royal Gardens of La Granja near Segovia and those of Aranjuez near Madrid, planted during the 16th century, are still maintained in large part as they were originally designed.

In visiting modern Spanish cities, travelers will be impressed with the many beautiful parks full of trees and gay flowers. In Madrid, the Retiro Park is the largest one. The thousands of horsechestnut trees that flower in April along the streets of Madrid will be remembered as a special feature of the Spanish capital. In Barcelona there is the huge Montjuich Park with a botanic garden. Other botanic gardens of Spain are in Santander, Santiago, Madrid, and Valencia.

Visitors to many Spanish cities, but especially Toledo and Seville, will be delighted to see balconies of houses filled with flowers during the summer. Traditional and modern Spanish gardens alike are closely associated with the patio, or outdoor living-room, so characteristic of all Latin counties. Space is frequently limited and water in most areas of southern Europe is often scarce. This is particularly true in Spain. Gardening, then, often means growing plants in containers, which in Spain are terra cotta pots, glazed jardinières, or tiled flower boxes. Often these are most attractive pieces—colorful and appropriate as decorative ornaments in association with plant materials which often consist of pelargoniums, petunias and long streamers of ivy.

Where there is sufficient space, Spanish people usually prefer the typical patio garden with trees for protection against the torrid midsummer sun.

Along the Costa Brava, the Riviera of Spain, in the northeast, several outstanding gardens have been developed in recent years. The Pinya de Rosa and the Jardín Botánico de Marimurtra, both at Blanes, are noteworthy among them.

At Granada, where the tradition of the Moors is still strongly evident, the small private garden called a *carmen** is the prevalent style. While some are elaborately executed, most of these gardens are modest and small, often less than a quarter of an acre in size, or in the larger ones not more than two acres. In all of them the overriding motif is the same in the use of running water, tile fountains, "embroidered" stone walks, and plants in terra cotta pots. Cypress trees must also be a part of the garden. In Prieto-Moreno's book "Los Jardines de Granada"** twelve of the outstanding carmens are illustrated in considerable detail, showing, for instance, the intricacies of construction, with scale designs of the gardens. Carmens are not public gardens, but almost any owner is delighted to show his garden to visitors who have a serious intent apart from one of sheer curiosity. Atmosphere, character, and intimacy are words that aptly describe the carmens of Granada. Indeed, they are inviting places to sip the finest sherry with a friend at sunset.

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*Spanish word meaning country house and garden, or villa.

**Published by Cigueña, Madrid, 1952.

Ivy geraniums tumble over the balconies of this house on the Plaza de Doña Elvira in Seville.

Madrid Botanic Garden

At Madrid there is a botanic garden of historic significance, especially to the New World, for the herbarium houses important scientific material on plants of the Americas. Founded in 1781, the garden played an important role during the height of Spanish influence in America in the introduction of American plants into European horticulture. The dahlia was one of these. The garden is administered by the university and is open daily for a small entrance fee.

The private road from the entrance of Pinya de Rosa to the residence of Señor Rivière leads past the Plaza Neptuno, from where the blue Mediterranean forms the backdrop for a view over the grounds.

Pinya de Rosa

M. Walter Pesman

On the rocky Costa Brava, or Spanish Riviera, near the town of Blanes, a fascinating new garden is found—the most modern in all Spain. Some call it the *Jardín de Aclimatación,* others *Mas del Sol,* "farm of the sun," but its owner calls it *Pinya de Rosa.* In this Mediterranean climate succulents and subtropical plants are extensively cultivated.

It was my privilege and pleasure to visit this garden in the summer of 1958 as guest of the owner, the gracious Don Fernando Rivière-Caralt. Here I observed one of the best cactus collections in the world, saw 650 species of *Mesembryanthemum* and its close relatives, and lunched with experts in the culture of succulents at a beautifully appointed table around which conversation swirled in five languages. Yet I had learned of the garden's existence only the day before.

I had been making a tour of European botanic gardens and had reached the Instituto Botánico of Barcelona in the Pare de Montjuich, marked on my list "Do not fail to see." It was a Friday and Luis Ruidor, the director, and Juan Pañella, planning expert, had been my charming hosts. I thought I had learned much about botanic gardens and had found Barcelona's Botanic Garden and well-kept parks among the best in Europe. After spending a great deal of time with Sr. Pañella, I was surprised to learn that all of this was a mere prelude to the Jardín de Aclimatación, where he would take me next day.

Early Saturday found us following the main highway northward from Barcelona toward Blanes. During the hour-long drive I learned that there is excellent collaboration between the Barcelona Botanic Garden and Pinya de Rosa. Every week-end Sr. Pañella works with industrialist Don Fernando, and the result is a garden that approaches perfection in botanical accuracy and cultural maintenance.

Don Fernando, who conceived the garden, is an amazing personality. A successful industrialist of Barcelona during the week, he is an enthusiastic gardener and horticulturist on week-ends. His estate covers an area of 100 hectares, about 250 acres, and that is a large garden anywhere. At the time of my visit it was only

18 years old, yet the mature palms and large specimens of cacti gave it a somewhat venerable character.

How can I describe Pinya de Rosa? When I try to analyze its charm I find myself at a loss because it embraces many things in one. There is its location on the Costa Brava, with a magnificent view of the Mediterranean; there is the variety of its topography, ranging from rocky declines to grassy slopes. There is the successful combination of a botanic garden within the carefully laid out grounds of a pleasant country estate of Catalonia. The typically Catalan home also adds its attraction, with its provision for outdoor living and its indoor elegance. Yet the essential attraction, uniting all others, is Don Fernando Rivière himself. I saw him as a plant lover, fine conversationalist, and, with Señora Rivière, as an engaging host and devoted parent.

The German cactologist Curt Backeberg, whom I met at Pinya de Rosa, has honored Don Fernando by naming a species in a new cactus genus *Leucostele rivierei*. Backeberg considers the collections at Blanes of prime significance.

In a day we could see only the outstanding parts of the estate—the distances making a walking tour impractical. We missed the swimming beach and could do only scant justice to the fine collections of *Opuntia*, *Mesembryanthemum*, *Agave*, *Aloë*, *Cereus*, and other succulents. The next day we saw some of the same species in the Parc de Montjuich above the port and in other parks in Barcelona, again under the guidance of Sr. Pañella.

Since my visit, Don Fernando has provided me with additional notes on the garden at Blanes. He says that his living plants represent a climax of various collections he has made since early youth. There are, he explains, four main collections of specialized plants: opuntias, of the Cactus Family—more than 380 species growing outdoors; and three other groups of succulents—Mexican agaves and African aloes and mesembryanthemums. The collections are planted systematically, by botanical relationships, for the convenience of scientific studies.

The tall cactus is *Leucostele rivierei*, named by the cactologist Curt Backeberg in honor of the owner of Pinya de Rosa.

Regarding other collections in the garden, Don Fernando says: "In the greenhouses and also planted in the ground, I keep a varied and large collection of *Philodendron, Ficus, Calathea, Maranta, Dieffenbachia, Alocasia*, and other plants. A smaller greenhouse contains orchid species which are flowering without difficulty. In another greenhouse I nurse a selected representation of bromeliads. A list of all the plants in the garden would include more than 5,000 kinds.

"Much new information has been gathered during studies of the plants in my garden, especially *Opuntia*. Several spe-

Beds of cacti at Pinya de Rosa are arranged systematically for study, according to their botanical affinities.

cies of *Opuntia* have been described from plants in my collection as new to science.

"Furthermore I have an up-to-date library of botanical works necessary for my studies, and an extensive file of data about plants in my collection. This gives easy aecess to material that is useful in my studies. Supplementing the file I have a collection of more than 2,00 pictures in color, which facilitate the study of plants, flowers, and fruits."

Don Fernando cordially invites visitors to Pinya de Rosa either for serious study or for the enjoyment of his fine, expanding garden in a delightful and refreshing environment. People from many lands, he says, have visited his garden, "magnificent in its setting above the intense blue of the Mediterranean Sea."

"It is at its best," he writes, "in the full tide of spring—about the beginning of May when the mesembryanthemum collection is flowering in a tapestry of color —but it is interesting at all the other seasons, too, for even in midwinter flowers are blooming." A minimum of two hours should be reserved for a visit to the gardens and greenhouses. To see the entire property, which borders the sea above 300-foot cliffs, an additional hour is required. A detailed viewing by a specialist would require a day or days, depending upon his interests. The situation of the property between two summer villages, Blanes and Lloret de Mar (50 miles northeast of Barcelona), gives it easy access.

Marimurtra

Formerly the private estate of Señor Carlos Faust, Marimurtra is maintained today as a private botanie garden, in accordance with the late owner's wishes. The garden covers about 40 acres on a high promontory above the Mediterranean, adjoining the garden of Pinya de Rosa, at Blanes along the Costa Brava, about 50 miles north of Barcelona.

Succulents predominate among the plantings. *Kalanchoë faustii* grown in the garden commemorates the name of the founder. Trees, shrubs, and herbaceous plants adaptable in the Mediterranean climate are also extensively planted. Subtropical foliage plants, in vivid colors, are the feature of one section.

A new extension to the garden is being developed as an arboretum. The older plantings are grouped attractively in a beautiful natural woodland of the Aleppo pine (*Pinus halepensis*). Plants are labeled throughout the grounds.

The garden is open daily to visitors for a small fee. At least two hours should be allowed to see the garden thoroughly.

The residence at Marimurtra on the Costa Brava makes a fine setting for some of the choice plants grown there. The large-leaved shrub in the foreground is *Wigandia caracasana* of northern South America, often seen in Mediterranean gardens. Blooming above the loggia is *Araujia sericifera*, a Peruvian vine of the milkweed family.

Agave bracteosa blooms in the garden of desert plants at Marimurtra.

The Moorish Gardens of Spain

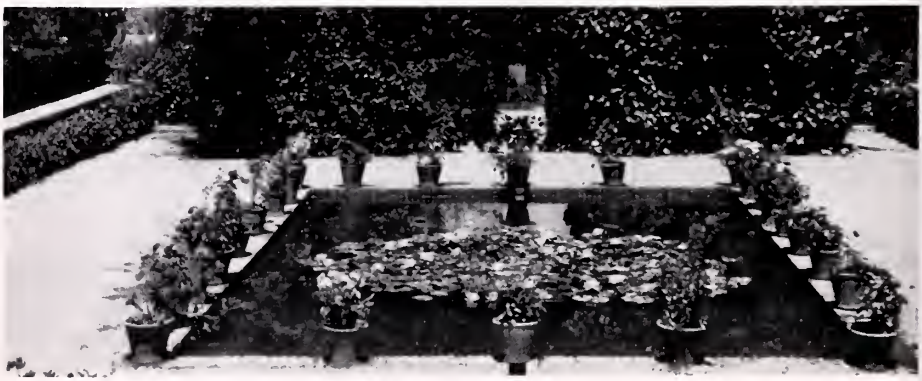
Lillian Nicholson Meyer

Not least among the landmarks of Spain are its Moorish gardens, the Alhambra and the Generalife at Granada, and the Alcázar in Seville. Of medieval vintage, these sophisticated and outstanding additions to gardening art may well be among the last remaining stepping stones between our own and the gardens of the ancient Babylonians, Greeks, and Romans. To see them, alone, is worth a journey to Spain.

As did the ancients, the Moors made of gardening a feature of luxury and so imparted into their creations a wayward charm and *joie de vivre* not found in other countries where the gardens of the same period were ecclesiastical rather than princely, and where horticultural skill was devoted to the utilitarian grounds of monasteries. Like Pliny's villa and the Hanging Gardens of Babylon, the Moorish gardens are feats of building and engineering, as well as planting. The Moors built lush oasis gardens in the midst of Spain's desert terrain. They terraced and tiled them, and watered them profusely with their systems of man-made streams and aqueducts connected with the distant Sierra Nevadas, highest mountains in all Spain.

The wall formed an important feature of Moorish gardens. One has only to wander through the walled Alcázar in Seville with its endless variation of courts within courts, its tiny fountains and baths of colorful tile, the terraces and orangeries, to understand the allusion to the walled gardens in the "Song of Solomon." The happy Moorish taste for geometric ornamentation, the fantasy, desire for privacy, the quiet contemplation of the long perspective, and the spirit of fatalism so characteristic of their art found a rewarding field of expression for them in their gardens. Like the Romans, they delighted in the aromatic broad-leaved evergreens that knew no season, such as boxwood, myrtle, laurel, and orange, and they planted fragrant herbs and flowers such as thyme, jasmine, and the rose. The full meaning of what these Moorish gardens can express is all unknown to him who has never lingered within the reach of this mingled perfume.

As in the great gardens of antiquity, it is the water that confers the last gracious note in these romantic establishments. Cascades, fountains, and channels bring life and emotion to the whole today through the same ancient system of tiles and leaden pipes that were installed by the gardens' creators. Always in the Moorish garden there is the characteristic low ripple of the fountain. In the evening when the vegetation and buildings melt into the shade, the silvery music of the



Water is part of the basic design of every Moorish garden. This small waterlily pool is at the Alhambra. Potted plants are characteristic ornaments.

Tile benches, clipped cypress arches, fountains, and potted plants, as shown in the gardens of the Alcázar, have set a pattern which has been admired and followed for many centuries in Spain.

running water creates a magical atmosphere, stirring the senses and calling up past splendors to the mind's eye. These are truly gardens from "Arabian Nights."

The Alcázar

The most imposing Moorish edifice in Seville, the Alcázar, is provided with a series of small gardens with tiled fountains, running water, myrtle hedges, and screens of clipped cypress hedges after the typical Moorish style. The gardens at Seville, though extensive and Moorish in concept, lack the spiritual quality of the gardens of Granada. Probably there is a reason for this, since the Moorish rulers abandoned their capital for long periods to escape the intensely hot summers of Seville—preferring the cool waters and breezes of the Sierra Nevadas and the Generalife at Granada.

Gardens of the Generalife

The 14th-century palace and gardens of the Generalife, at Granada, sometimes referred to as the gardens of "Arif" (the architect), are probably the most untouched piece of Moorish gardening art. The name is a distillation of an Arabic term that means "sublime garden." This was the summer palace of the Moorish rulers who favored the cool breezes of the mountains to the torrid summers of Seville, their capital. The gardens are greatly elevated, overlooking the Vega, the fertile plain that stretches out beyond the city of Granada. The palace is a small but exquisite white edifice. With its finely regulated garden terraces obviously planned to fit into a small space, its *eaux d'artifices* and its splendid view, it overlooks what is probably the most breathtaking scene in all Spain. The many courts are all amply provided with water and there is a water stairway in the garden's upper part.

The principal court is the Patio de la Ría which sets the note of formal architectural style. It is flanked by two white pavilions situated along the axis of a man-made watercourse enlivened by scintillating jets of fountains leading down the center. This court (now badly planted) looks out over fine specimens of myrtle growing beneath. From this patio one passes into the beautiful court that gave rise to a legend about the "Sultana's cypress." In the center of the court, which is surrounded by balconies covered with ivy, is a large basin with a magnificent fountain that can send its spray to a height of 60 feet. The abundance of water in this court is delightful and its character is that of complete spiritual concentration and repose.

The view from the courts of the Generalife is the chief decorative feature of the gardens. From his greatly elevated position the spectator can look out over the red walls of the Alhambra hugging the precipice below. He sees the ancient Moorish city called the Albaicín with its endless elevation of whitewashed houses, church towers, convents, villas, alleys, gypsies' quarters, and cypress trees all mingled in splendid confusion. Lastly, he gazes over the historic and fertile Vega, the plain that stretches away to a point where purple, undulating foothills reach the snow-covered Sierra Nevadas. It is a brilliant scene. Obviously the inhabitants of this noble spot, in spite of their man-

→

Greatest of all the Moorish gardens of Spain is the Generalife, of which some characteristic views are seen on opposite page. *Left above*, on a high balcony a fountain lends its music to the mood of contemplation induced there. Potted plants are equally a symbol and a style. From the arched window can be seen the view at the *right*—the squared tops of the precisely clipped cypresses. The way these trees appear from one of the walks below is shown at *center left*. Another view from on high is at the *right*, where flowering shrubs occupy the center of the geometric figures created in boxwood. This garden is at the foot of the tower of the Palace of the Generalife. *Below* is another view showing cypresses, both clipped and natural, framing the fountains and potted plants.

The Court of the Sultana's Cypress is a pleasant retreat in the gardens of the Generalife.

Patio and enclosed garden of a large house opposite the Cathedral Mosque at Cordova

made luxurious surroundings, delighted in the quiet contemplation of long perspectives of natural scenery.

The approach to this elegant estate is along a celebrated avenue of imposing cypresses overlooking a cypress garden. In spring masses of the Banksian rose bloom with festoons of yellow blossoms as they grow over the green cypress branches. Though this cypress avenue obviously dates only from the 18th century, close to five centuries later than the palace and gardens, it is in excellent taste with the whole.

The Patios of Cordova

Mary R. Bull

The inhabitants of Cordova (Córdoba), in southern Spain are justifiably proud of their beautiful patios. Every spring the *Ayuntamiento* (Town Council) organizes a competition and prizes are awarded to the patios that are the best kept and most beautiful.

One doesn't need to be a friend of the family to see these patios. As one strolls through the narrow streets leading to the Cathedral Mosque one sees them on either side. Many belong to quite humble folk.

To an Anglo-Saxon one's home is one's castle. We do not like curious strangers looking in. But Spaniards are different. To allow friends and strangers alike to admire their patios, they always leave the large front door open onto the street. Beyond a short marble entrance is a highly ornate wrought-iron door surrounded by glazed *azulejos*—the brightly colored tiles of which the Spanish are very fond.

During the heat of the day the glimpses of water and green plants in the patios are a cooling sight. Till nearly midnight one can see the family sitting round chatting, eating, playing the guitar, and enjoying watching the people in the street while they themselves are being watched.

No one will mind if you stop to admire a particularly beautiful philodendron growing up a marble pillar or a delicate

nephrolepis fern hanging from a wrought-iron basket. On the contrary, you will probably be invited in.

This once happened to me. With typical Spanish courtesy the owners pressed me to stroll round and take photos. The house had an open patio with a fountain framed with creeping plants against one wall. Through a double arch was a small enclosed garden.

Hanging from the walls I saw several partridges in small cages. They explained that these were used as decoys during the shooting season. Singing birds were also kept in cages, among them goldfinches and canaries.

Ferns, among them varieties of nephrolepis, pteris, and adiantum, are popular. So are aspidistras, also philodendrons and other aroids, especially the monsteras with huge leaves. Variegated ivies and bougainvilleas are trained against the white walls, and hibiscus, banana trees, and palms are grown in tubs. Carnations and geraniums are massed in small pots round the fountains.

The Spanish are also fond of roses, and these are grown successfully in large earthenware jars. Flowers that perfume the air at night are favorites. Among there are the white phyllocactus,* datura, and the *dama de noche* or lady of the night.**

The patio is the heart of a Spanish home, round which the life of the family revolves. A necessity in such a hot climate, it takes the place of garden and drawing room.

**Editor's note:* This is probably a species of *Epiphyllum*.

** Probably a night-blooming cereus, of which there are many kinds.

Left: Through delicate iron grillwork one can look from the street into the patio of a home in Cordova. *Right:* A small ornamental well in a corner of a patio is covered with *azulejos* (glazed tiles). Bucket and top of well are of burnished copper.

The Jardín de la Isla, the royal park at Aranjuez, is two things—a restful grove of trees, as shown above, and boxwood-and-fountain plantings of Italian influence around the palace of Philip II.

Jardín de la Isla, the Royal Garden at Aranjuez

Aranjuez is a small town, bordering the Tagus River about 30 miles south of Madrid. Since the 14th century the Spanish Royal House has used it as a retreat. In the town itself, lofty English elms and sycamores are extensively planted to bring much-needed shade to the otherwise arid and barren plain.

Within the royal enclosure is a large park dominated by sycamores (*Platanus*). The Jardín de la Isla covers several acres on the river adjacent to the Royal Palace. Created in the 16th century, the design of the garden imitates the Italian style of the late Renaissance period with fountains and clipped boxwood hedges. There are also elaborate designs in bedding plants.

The Jardín de la Isla is open daily to the public. A small entrance fee admits the visitor to the palace and grounds.

Linnaeus's home at Hammarby is a mecca for botanists as well as a pleasant place for any traveler to see. The garden has been restored to its original plan. The small building on the right has the sod roof often seen in Sweden.

Linnaeus and His Gardens

Carl Linnaeus, the great 18th-century Swedish naturalist, who is often called the "father of botany," lived at Uppsala, where he was professor in the university. In 1788 he acquired Hammarby for his country home, and did much of his writing there. He also maintained a garden of wild flowers, in contrast to the botanic garden of the university, which was attached to his Uppsala house. Here the plants were arranged according to the system of classification that he originated. This garden, which had fallen into decay after his death, has recently been restored to its original plan and condition, and opened to the public. Hammarby is maintained as a national monument of Sweden. It is a shrine for plantsmen the world over.

Favorite among the wild flowers that he loved was this little northern bog plant, the twinflower. At Linnaeus's own request, a fellow botanist gave it the scientific name of *Linnaea*.

A rock garden in a forest glade near Lake Möckeln, Karlskoga, Värmland. Native rocks are customary parts of many gardens in Sweden. Used as steps they are interspersed with interesting small plants.

Using the natural landscape, whether of water, rocks or soil, the Swedish people create gardens that blend unobtrusively into their surroundings. Above is a planted pool on a private estate near Stockholm.

Every railway station and whistle stop in Sweden has a garden planted and maintained by the Swedish State Railways. The first such gardens, established in 1862, were hardwood plantings designed to keep sparks from steam engines from starting fires. Their aesthetic value was soon realized and flower beds, lawns, and benches followed, such as in the garden shown above.

Public Parks and Gardens of Sweden*

Appropriately, Sweden has a number of botanic gardens for carrying on the Linnaean heritage. Besides the Hortus Linnaeanus at the University of Uppsala, there are institutions, with grounds that can be visited, at Göteberg, Lund, and Stockholm. Arboretums for coniferous trees are located at Göteberg and Kivik. The Kungsparken Arboretum also is at Göteberg, as is the park of the Garden Society, where fine flower displays can be seen.

The parks of Stockholm are noteworthy for their landscaping. The Millesgarden there includes fine sculpture; the Royal Park at Drottningholm is designed in 17th-18th century style with parterres as one feature.

Halsingborg and Malmö also are noted for their parks. At Rottneros, near Karlstad, is another splendid park ornamented with sculpture.

Around Båstad and Norrviken, in the southwest there are many gardens worth seeing.

*This information has been taken from the forthcoming volume, "The Gardener's Directory" by J. W. Stephenson, and is included here in advance of publication by permission of the publishers, Hanover House (a division of Doubleday & Company, Inc.).

SWITZERLAND

Magnolias and camellias bloom against the mountain snows across Lake Maggiore in springtime.

Gardens of Southern Switzerland

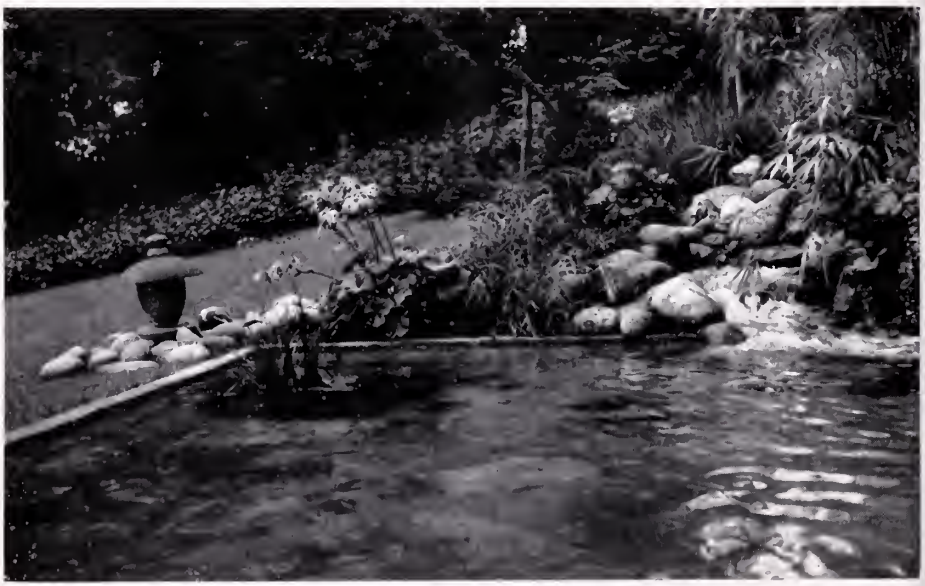
In the south of Switzerland facing the Italian border is a favored region of mild climate with relatively little frost and snow, a region where it is possible to grow hardy palms and other plants common farther south along the Mediterranean. Particularly favored are gardens in the Swiss part of Lake Maggiore—notably at Locarno and Brissago—and around Lake Lugano. At an altitude of generally less than 2,000 feet, the lush gardens are virtually subtropical in character. Four or five kinds of palms thrive, eucalyptus grows nearly 75 feet tall, camellias and magnolias bloom in many outdoor gardens, and Mediterranean cypresses may be seen to rival in size the trees of much farther south.

In addition to the Swiss gardens mentioned on page 48, localities and gardens especially worth visiting in this region include:

Mosogno in the Onsernone valley.
City Park, Locarno.
Villa Veronica, Porto Ronco.
Islands at Brissago, Lake Maggiore.
Park of Villa Maria, Melide.
Park of Villa Ciani, Lugano.

Plants of warm regions grow with success in Switzerland's southerly lake district. *Left above:* monkey puzzle (*Araucaria araucana*); *right:* cork oak (*Quercus suber*); *left below: Fatsia japonica* 'Moseri'; *right:* blue palm (*Erythea armata*).

This plant (*Loropetalum chinense*) growing in a garden of the southern lake region of Switzerland, deserves wider cultivation in the United States. It is a member of the witch-hazel family.



At Horgen, near Zurich, a pleasant water garden was created by E. C. Trüb. The flowering plant at the corner is the bright orange *Ligularia clivorum*.

The first Swiss horticultural show, held in Zurich in 1959, presented some interesting patterns for garden design in one section of its displays. The exhibition covered more than a million and a half square feet of ground.

A Few of the Western European Nurseries of Interest to Visitors

Note: The street address, where given, follows the name of the town or city, which is shown in small capital letters.

AUSTRIA

WITHIN 20 MILES OF VIENNA

Franz Praskac, FREUNDORF, near Tulln. Ornamentals, especially woody plants.

Christian Friedrichsen, TULLNERBACH-LAWIES, Seestrasse 4. Conifers.

Karl Teubl, TULLNERBACH-LAWIES, H. Mühlerweg 289. Conifers.

L. C. Visser, PRESSBAUM, Weidlingsbachstrasse. Conifers.

BELGIUM

De Schrijver, OOSTAKKER. Greenhouse plants.

Tollenare A., ST. AMANDSBERG (Ghent), Antwerpse steenweg 225. Greenhouse plants.

De Coninek, ST. DENIJS-WESTREM. Orchids.

Firm Bier, MELLE. Greenhouse plants, azaleas.

Firm Moerman, DE PINTE. Begonias, gloxinias.

De Bisschop, DRONGEN. Camellias.

Andries, GRIMMINGE. Dahlias.

Firm Van Hecke, ZAFFELAERE. Outdoor azaleas.

Firm Flandria, BRUGES. House plants.

Firm Muylaert Bros., MOORSEL. Cut flowers.

Firm Draps, STROMBEEK. Forced plants.

Firm A. Calle, BOSKANT (Wetteren). Ornamental woody plants.

Braekman A., WETTEREN, Massemen steenweg. Ornamental woody plants.

De Coninck-Dervaes, MALDEGEM. Ornamental trees, shrubs, conifers.

DENMARK

Frost A/A Plantskoler, BORKOP.

FRANCE

PARIS AREA

Vilmorin-Andrieux et Cie., VERRIÉRES-LE-BUISSON. General nurseries, arboretum, and experimental grounds for plant breeding. Home of the largest and oldest horticultural firm of France, dating back to the 18th century. A large collection of foreign trees and shrubs is maintained in the arboretum. Paris store on Quai de la Mégisserie.

Georges Delbard, PARIS, 16 Quai de la Mégisserie. General.

Georges Truffaut, VERSAILLES. General, especially roses and other woody plants.

Marcel Leconfle, PARIS, Boissy St. Leger. Orchids, greenhouse plants.

ORLEANS

Raymond Chenault, Clos Fleuri. Large collection of fine shrubs and trees, some developed by the family over the past 70 years, among them *Berberis* × *chenaultii*, *Viburnum* × *chenaultii*, and *Symphoricarpos* × *chenaultii*.

Grandes Roseraies du Val de Loire. General.

Grandes Pépinières Lambert.

Many other establishments are located around this important nursery center of northern France.

ANGERS

F. Delaunay, 100 Route des Ponts-de-Cé.

Charles Détriché, 123 Route des Ponts-de-Cé. General nursery stock.

NANTES

Claude Thoby, Route de Paris, Carquefou. Camellias.

FRENCH RIVIERA

Herve-Fautrelle, GOLFE-JUAN.

G. L. Dental & Co., GOLFE-JUAN.

Th. Fisch, VALLAURIS.

GERMANY

At least one-third of Germany's 2,000 tree and shrub nurseries are located in Holstein, just north of Hamburg. Forest tree seedlings are a leading crop here. Another important nursery area is in East Friesland (Ostfriesland) in northwestern Germany near the Netherlands border. The quality of nursery stock here is unexcelled.

Roses

Kordes Rose Nursery, ELMSHORN, near Hamburg. Originator of many outstanding hybrids, especially in floribundas.

Tantau Rose Nursery, near ELMSHORN. Actively engaged in breeding new types.

Trees and shrubs

Rudolf Schmidt, RELLINGEN, near Elmshorn, north of Hamburg.

Timm & Co., ELMSHORN.

H. A. Hesse, WEENER/EMS, East Friesland. Germany's largest assortment of rare trees and shrubs hardy in northern Europe.

Böhlje Nursery, WESTERSTEDE, East Friesland. One of the most beautifully kept nurseries to be seen anywhere.

H. Bruns, WESTERSTEDE. A small nursery full of unusual and well-grown plants.

Joh. Bruns, BAD ZWISCHENAHN, near Oldenburg, East Friesland. A large, well operated establishment.

Rhododendrons

Dietrich Hobbie, LINSWEGE, near Westerstede, East Friesland. Doing the most important work in development of new hybrids.

Perennials

Georg Arends, WUPPERTAL-RONSDORF. The leading German breeder of perennials.

Kayser & Seibert, ROSSDORF, near Darmstadt. A large commercial firm offering high quality material.

ITALY

Nursery of Ansaloni, Bologna.

Giardino Allegra, Catania, Sicily.

Sgaravatti, the largest nursery firm in Italy, with three branches: Rome (just north of the city on the main road to Florence), at Pistoia, near Florence, and at Saonara, near Padua. At the branch in Rome there is an exhibit of model home gardens. In some examples, classical style appears in clipped hedges, even in small gardens. Other models show the modern Italian garden breaking with tradition and using flowers in mixed array, as in an English flower garden. The nursery is a completely modern establishment with cash-and-carry methods strongly entrenched in sales techniques.

Note: Around Pistoia, the nursery center of Italy, there are many small nurseries. At Ventimiglia and Bordighera, not far from San Remo on the Italian Riviera, are markets where flowers are auctioned off daily, starting at 3 p.m. Here, carnations, roses, strelitzias, and other blooms can be bought in their season at very low prices.

NETHERLANDS

Annuals

Sluis & Groot, Enkhuizen, North Holland province, on the IJsselmeer.

Bulbs

C. G. van Tubergen (operated by Th. Hoog), Haarlem. Largest assortment of commercial bulbs in the Netherlands.

Conifers

L. Konijn & Son, Reeuwijk, near Boskop. Largest nursery collection of conifers in Europe.

Many other nurseries specializing in conifers are in the Boskoop area.

Cut flowers

The cut-flower industry is centered at Aalsmeer, where there is also an experiment station and flower auction market, called "Bloemenlust."

Ferns

Lemkes, Alphen on the Rhine, north of Boskoop, near Leiden.

Hothouse plants

Firm Bier, Nieuwerkerk, near IJssel.

A. Maarsen, near Aalsmeer.

Nursery stock

At Boskoop, 675 nurseries deal in nursery stock. Zundert, near the Belgian border, on the main road to Antwerp and Brussels, also has several nurseries especially for trees. Pierre Lombarts here has the largest nursery collection of trees and shrubs in the Netherlands.

Perennials

Royal Moerheim Nurseries, Dedemsvaart, northeastern Netherlands.

Street trees

Alphons van der Bom, Oudenbosch, near Zundert.

Succulents

K. Edelman, Temple Nurseries, Reeuwijk, near Boskoop. Millions of cacti grown in greenhouses in an area that is below sea level and surrounded by canals.

NORWAY

Brynes Plateskoler, Stavanger (on the coast, southwest of Oslo).

PORTUGAL

Companhia Horticola, Oporto. The country's oldest nursery, built on terraces above the River Douro. Camellias are one of its specialities. Some of the original woody plants, 100 years old, are still growing there.

Moreira da Silva & Filhos, Oporto. Camellias, fruits, and greenhouse plants.

Flora de Carcavelos, Carcavelos (outside Lisbon), Estrada da Torre, Quinta dos Lombos. General.

SPAIN

General nurseries

Nursery of Bourguignon, Madrid. Greenhouse plants also.

Viveros Castilla, S. A., nurseries at Aranjuez for trees and shrubs, at Madrid for herbaceous plants. Beautifully grown plants.

Roses

Pedro Dot, San Feliu de Llobregat, near Barcelona.

Camprubi, Cornella, near Barcelona.

Rosas Torre Blanca, San Feliu de Llobregat, near Barcelona.

SWEDEN

Erik Läcks Plantskola, Rönninge (suburb of Stockholm).

Nysäters Fröhandel, Örebo, Nygatan 24.

Trädgårdsförening, Göteborg C.

SWITZERLAND

Trees and shrubs

W. Rusterholz, Oberrieden, near Zurich.

Brothers Hauenstein, Rafz, near Schaffhausen.

P. Daepp, Münsingen, near Berne.

J. Hug, Dielsdorf, near Zurich.

H. Zulauf, Schinznach-Dorf. A show garden, featuring roses, other flowering shrubs, and conifers is open the year round. At one side a straw-covered house, such as was common in Switzerland through the 19th century, serves as a shelter.

Greenhouse plants

Gubler Nursery, Pfäffikon, Zurich.

Camellias

Leo Suter, Tenero on the Ticino, near the Italian lake district of Switzerland.

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AUTUMN
1960

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Mantids

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L. 16 NO. 3

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Editorial

CYNTHIA WESTCOTT, *Guest Editor*

PETER K. NELSON, *Associate Editor*

and the Editorial Committee of the Brooklyn Botanic Garden

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Photo by J. K. Holloway

Biological control of Klamath weed, a serious pest of pastures, in California. Flowering mass of weed in foreground pasture. Grassy area behind has been cleared of the weed by introduction of *Chrysolina* beetles which feed upon it.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES
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A frequent question asked at the Botanic Garden is "Why are there so many more plant pests now than there used to be?" The answer is, in part, that the concentration of a specific crop in a certain region brings a concentration of insects that more or less exclusively feed on that crop; it makes little difference whether it be wheat, cotton, citrus trees or roses. To control the pests, chemical sprays are widely used. For the longer term future researchers are working on natural means of control, and some of these are already highly successful.

In the pages that follow you can learn about means of eliminating or drastically decreasing insect pests by "biological control," that is, through the introduction of their natural enemies—other insects which act as parasites or predators and, in sufficient numbers, will destroy the enemy—or, by the introduction of microbial diseases; or by the sterilization of males, etc. And in a still broader sense of biological control, see the frontispiece (p. 2) where a particular insect is being used for weed control. Weeds often outperform pestiferous insects as competitors against wanted plants. Their natural control is intriguing to contemplate.

Raimon Beard points out in the first article in this Handbook (which is *must* reading for everyone), that man is a part of nature and as such he can scarcely upset the balance of nature. He can only shift it. Herein lies the great risk in man's tinkering with natural phenomena; the extent of the shift is almost impossible to predict in advance. All life is in competition with other life, and our need is for greater wisdom in controlling our plant and animal competitors.

Many readers will perhaps wonder . . . "What is there here that I can apply to my own pest control problems?" The answer is "understanding." Learn to recognize the helpful as well as the harmful insects, and take care not to unnecessarily destroy the former. This is at least one route that leads to the natural control of insect pests.

Some insects play chiefly beneficial roles, and many of these prey on pest insects. Such a one is the "preying" mantis. A casual glance seems to suggest that it is a "praying" mantis. Either spelling describes it aptly. The fact is that it is a good citizen because it devours many harmful ones. The lady beetles (lady bugs), with the exception of the Mexican bean beetle, are all good citizess.

We are deeply indebted to Editor Westcott and the experts she invited to write on this subject about which most of us know so little. Indeed, our appreciation of the role of entomologists will reach a new high as we learn about what they are doing on the biological control of plant pests. That there has been considerable progress in this field will be evident from the many enlightening articles that follow.

This is one of the outstanding Handbooks in the **PLANTS & GARDENS** series, and though it may not be wholly recreational reading, we commend it to you without reservation.

Sincerely yours,

George S. Avery

Director

For Index of parasites and predators, see inside back cover (p. 97).

WE FACE UNCOMFORTABLE DECISIONS*

Raimon L. Beard

VAST areas of this earth still are relatively free from the influence of man. Great mountain ranges, extensive water areas, desolate arctic regions, barren deserts, and dense jungles remain inhospitable to human habitation. Yet in these areas life of different types abounds, and man seems insignificant. Elsewhere broad cultivated fields, irrigated deserts, and flood-controlled river valleys amply demonstrate human ability to provide living requirements. On the one hand, man is arrogant when he assumes he can upset the balance of nature. On the other, the possibility of adjusting the environment to meet human needs places nature in a different perspective. The phrase "upsetting the balance of nature" is frequently voiced in criticism of pest control programs. It is timely, therefore, to examine the concept of the balance of nature and our place in it.

The balance of nature is not simply an abundance of birds, chipmunks, and flowers for us to enjoy, adequate fish to catch, and plenty of ducks and rabbits to hunt. Basically it is the interaction of all life and death. The balance of nature is not a static equilibrium, but an active, adjusting, interdependent, highly competitive, complex system of which man is a definite part.

Life constantly changes, with or without human activity. In New England the bare field, if left uncultivated, gives way to ragweed, goldenrod, and other weedy growth. Brushy vegetation crowds out the weeds, later yielding to red cedar and gray birch. Oaks and hickories or oth hardwoods come in, and their anteceden die out. The trees get big, shade out t wildflowers and bushes, and in their tu grow old and die. At each stage of th moving picture, insect and other anim life is active in hastening change, som times passive in being affected by t change; it is never completely neutra The numbers of plants and animals flu tuate widely from season to season ar from place to place.

Probably no one believes that the changes and plant-animal relationshi are entirely due to chance, helter-skelte forces. Some early natural historians, b ing of religious bent, attributed the dire tive forces in nature to divine guidanc Thus the English entomologists Kirb (the rector of Barham) and his ass eiate, Spence, writing in 1826, said, "A all-wise Providence has proportioned th number of each group and species to th work assigned to them." Others have b lieved that any providential guidance an indirect one, operating through nat ral laws.

It was 160 years ago that Malth wrote: "The germs of existence contain in this earth, if they could freely develo themselves, would fill millions of worl in the course of a few thousand yea Necessity, that imperious, all-pervadi law of nature, restrains them within th prescribed bounds. The race of plan and the race of animals shrink under th great restrictive law; and man cannot b any efforts of reason escape from it."

*Reprinted, with permission, from *Frontiers of Plant Science*, May, 1959.

We Are a Part of Nature

Malthus' concept of the struggle for existence, which stimulated Darwin's great theory, contains the essence of even modern theories of populations. Malthus' two principal points were that shortage of food is the ultimate, if not the immediate, means of population control, and that man is not excluded from nature in this respect.

The struggle for existence is no idle phrase. The changes in nature are not made harmoniously. Sometimes they result from such catastrophic events as floods, drought, and violent storms; sometimes they result when some organisms crowd out others less fit. Competition is keen—not only among individuals but among species. Every gardener knows this; his flowers and vegetables cannot meet the competition of weeds without his help. As Malthus emphasized, we, too, are a part of this competition. *Man* is not a detached director of affairs like the gods of Olympus. *We* are born and die, eat plants and animals and in turn are fed upon by plants (parasites). *We* compete with other animals whose requirements for food and other resources are the same as ours. *We* are subject to natural forces and inescapably are a part of nature.

To live successfully in an environment plants and animals must be well-endowed with the properties for living there. To meet competition, plants and animals must use whatever means they have at their disposal. It is natural, therefore, for us, too, to use our resourcefulness. Whether we use our means wisely is another matter, but it is natural. If our lives are threatened by disease organisms, it is natural to use antibiotics. (The fungi have been using them for ages.) If our desires and needs are threatened by insects, the use of insecticides is a perfectly natural method of protecting our requirements. (For millions of years, spiders, scorpions, and many predatory insects have used chemicals, their venoms, in getting food and meeting their competition.) This being so, as a part of nature we can scarcely upset the balance of nature, but we can shift it—just as do all other living things. The important difference is the degree to which we can shift it. But we are not alone in this, either. Physical forces shift nature in a dramatic way; so can living things such as plagues of locusts and hordes of rabbits.

Were we not able to participate in directing the course of nature significantly, far more of our population would be starving. As with many animals, shortage of food would long since have limited our numbers just as Malthus predicted. Even at present the population picture differs greatly in the bazaar of an Asian city, in New York's subway at rush hour, or in Connecticut suburbia. Every four months the inhabitants of the world increase by as many people as now live in New York. How long we can postpone the time when our numbers over-run our food supply remains to be seen. More and more we must shift nature in our favor if we are to feed, clothe, house and transport our ever-increasing masses.

Our wisdom in controlling our plant and animal competitors will come, not from ceasing to shift the balance of nature, for this we must do, but from the understanding of directive forces governing populations. We may thereby more intelligently decide our actions. We know, for example, that it is far easier to reduce populations than to eradicate them. We know, too, that plants and animals have remarkable powers of genetic adaptation. But we cannot expect these powers to work in our favor in those organisms we seek to increase and at the same time not to work against us in those organisms we seek to destroy.

Our way of life is changing, whether we like it or not. Our struggle for existence and our competition, even among ourselves, are becoming more complicated. More and more uncomfortable decisions and choices will have to govern our actions, for nature is not a personal friend of ours, regulating its creatures in numbers to suit us.

WHAT IS BIOLOGICAL CONTROL?

Theodore W. Fisher

THE FLYCATCHER capturing an insect in flight, the toad lapping up a grub, the ladybird beetle devouring an aphid—these are commonly observed actions which may typify biological control to the home gardener. However, there is considerably more to the subject than these simple observations might indicate, and it is the intent here to present a rather hurried look at certain aspects of biological control as they are interpreted by entomologists actively working in this thought-provoking approach to problems of pest control.

Fundamentally, biological *control* is the suppression of the reproductive potential of organisms through the actions of other organisms. In nature this is a continuing action which mainly is responsible for the fact that only one percent of the approximately 1,000,000 named plant-feeding insects and mites are listed as pests of agriculture world-wide.

In the United States approximately 600 species of insects are listed as pests of agriculture. A major reason for insects acquiring pest status is that they may be introduced on the host plant (crop) without all of their natural enemies. During the past 70 years natural enemies of insect pests have been introduced into over 40 countries with great success in controlling previously introduced plant pests. In the several cases where the biological method is credited with complete control of the pest, it has been proven to be economical (including the cost of developmental research), permanent, and safe. The agents of biological control discussed here are parasitic or predaceous insects and microorganisms which attack pest insects or weeds. Other creatures which have been utilized as agents of biological control include nematodes, snails, fish, amphibians, birds, and mammals. When a biological control entomologist mentions beneficial species, he is referring to the natural enemies of insect pests—not to honey bees or silkworms.

The purpose of this article is to familiarize the reader with the scope of biological control, its history, methods, economics, limitations, and future possibilities in the control of insect, mite, and weed pests of agricultural crops.

Scope of Biological Control

In nature a balance is known to exist between plant-feeding insects and their natural enemies. Since this balance can be shifted through the manipulation of environmental factors the practice of biological control is, in essence, applied ecology.* Methods used involve certain ecological approaches such as the importation of beneficial organisms, their mass production and periodic colonization, and the evaluation of native or introduced beneficial species with a view toward promoting their conservation and increase.

The terms "natural control" and "biological control" are not synonyms since properly used, biological control is but one facet of natural control. In its inclusive sense, natural control is the suppression of organisms unaided by man that may result from the effects of physical or biological factors. For example it is generally recognized that climatic extremes afford the environmental limitations within which plants and animals can exist, and sharp changes in weather or holocausts such as fire or flood can reduce simultaneously populations of both pest species and their natural enemies. Factors which reduce populations in this manner are properly termed "abiotic factors," since their action is completely independent of the biological entities concerned. Many insecticides would also fall into this category. Population change also result

*Ecology—the study of the relationships of plants and animals to their environment and to each other.—Ed.

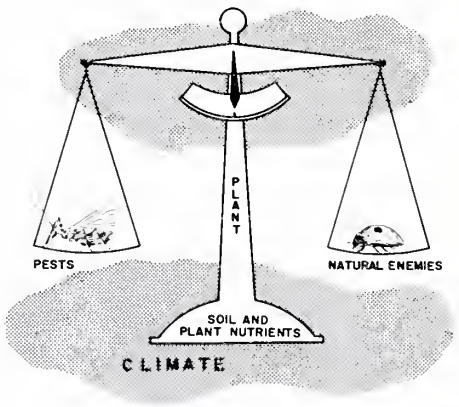
'om the interrelations of plant and ani- al species which are associated in a par- cular environment, as in the forest, field, r garden, for in any environment the ıecessant struggle for existence results 'om competition for space, food, and 'ater.

Some insects feed on plants, and if ıey happen to include in their diet plants f aesthetic or economic importance, they re labeled "pest" species. Included in ıe same environment will be certain or- anisms which feed upon them and whose ctivity prevents the pests from increas- ng as much as they otherwise would. Such organisms are termed "biotic fac- ors," and they tend to regulate popula- ions of pest species so that the actual ıumbers concerned oscillate above and ıelow a certain average value which is ermed the "equilibrium position" for the ıarticular population. This is an area of reat interest to entomologists, and the tudy of population change is known as 'population dynamics." People concerned vith insect pest problems try to arrive it a population density figure termed the 'economic threshold" above which eco- nomic loss will occur. If the pest species ontinues to multiply beyond the economic threshold in spite of opposing biotic or abiotic factors, a grower is forced to seek additional help in his particular pest- control problem.

Included among the natural enemies of pest insects are insects called "parasites" and "predators" and their mode of devel- opment furnishes the basis for separation. Insect parasites can complete their devel- opment on a single individual of the host (pest) species. Insect predators, how- ever, complete their growth only by feed- ing on several individuals of the pest species. There are other important dif- ferences. Parasites tend to be host spec- ific, that is, a given species of parasite will attack only certain plant-feeding in- sects, and it is the immature parasite feeding within or on the pest that kills it. Most predators are general feeders, and feeding occurs by both larvae and adults. For example, when a ladybird beetle larva or adult has consumed most of the aphids within its area of search, it will turn to red spider mites or perhaps immature white flies for sustenance. Al- though there are some noteworthy exam- ples of predators achieving commercial control of their hosts, most biological con- trol entomologists believe that parasites, because of their restricted host range, offer the best possibilities for introduction against specific insect pests.

The term "equilibrium" has been used, and by word association we think next of balance, and since we are concerned with biotic factors, fluctuating populations, environment, and the like, we may begin thinking of the familiar phrase "balance of nature," or preferably "natural bal- ance." A simple T-beam laboratory bal- ance provides a good analogy of natural balance and serves to interrelate the terms used thus far (see below).

Somewhere on the scale is the threshold of economic injury. When this point is passed, control measures must be used to re-establish the former balance. A scale in balance swings in equal ares (popula- tion oscillations). The difference between the scales and natural control is that the scales will eventually stop swinging. Not so in nature, where "balance" is an arith- metic mean and populations constantly increase or decrease in relation to it. In the diagram it will be seen that climate, a major physical factor of the environ- ment, acts on all the components although not necessarily with equal results, and



Natural balance

that they may act on each other with resultant imbalance in the system. This shifting balance in the numerical relationships among species (population dynamics) can be understood only by thorough long-term ecological studies.

At an early date observant people became aware of the predator-prey relation, and the applied use of biological control was a natural result.

History of Biological Control

The oldest known use of insects to control other insects antedates recorded history, and the same method is still in use. I refer to the practice in China and elsewhere in the Orient of placing bamboo poles between trees to serve as bridges for the movement of a predatory ant, *Oecophylla smaragdina* F., which reportedly keeps citrus trees free of damaging populations of caterpillars and certain other pests.

In the 1600's the first accounts of insect parasitism were published, and in the 1700's parasite biologies were first published. The possibility of using syrphid flies to control aphids was suggested by Erasmus Darwin in 1800, and in 1816 Kirby and Spence recommended the use of ladybird beetles for aphid control on hops. During the remainder of the 19th century there were several attempts at utilizing the biological control of insect pests. The first international movement of beneficial insects for pest control occurred in 1873 with the shipment of a predaceous mite from the United States to France in an attempt to control the grape phylloxera. In 1888 the successful introduction and establishment of the vedalia beetle, *Rodolia cardinalis* (Muls.), into California from Australia for the control of cottony-cushion scale literally put biological control on its feet.

Since 1900 the biological method of pest control has proven of value, not only in the partial to complete control of many pest insects throughout the world but of certain weed pests as well. For example, prickly-pear cactus in Australia is still controlled by a moth introduced from Argentina in 1925, and in 1944 *Chrysolina* beetles were first introduced from Australia into California where they are successfully combating a serious range weed *Hypericum perforatum*.

In 1923, biological control work in California was transferred from the State Department of Agriculture at Sacramento to the University of California. Originally the staff numbered three persons and at present it includes over 60 people. Today in the continental United States biological control is being investigated full time principally by this group and by the U. S. Department of Agriculture Agricultural Research Service, Bureau of Insect Identification.

Even a sketchy history of biological control would be incomplete without mentioning the development of techniques for the mass production and artificial propagation of beneficial insects for periodic colonization against various introduced insect pests. Economical propagation of imported natural enemies can enhance greatly their establishment and bring about control of their hosts in much shorter time than when small numbers only are available. Thus, in 19 the mass production of citrus-attacking mealybugs on bleached potato sprouts permitted wide dispersal of predators and later, parasites of these important pests. To date in this country and abroad there have been several highly successful mass production programs of various degrees of magnitude.

Successful biological control programs such as the control of cottony-cushion scale in California and elsewhere, the coconut moth in Fiji, the sugarcane leafhopper in Hawaii, the eucalyptus snout beetle in South Africa, and certain citrus mealybugs and black scale in California have created world-wide interest in the method of insect pest control with the result that the governments of several countries have established facilities for research toward this end.

Among the organisms which attack plant-eating (phytophagous) insects are viruses, fungi, bacteria (page 9), protozoa, and nematodes. This phase of biological control is handled by microbiologists, and

Diseased caterpillar; three days ago it consumed leaf material previously sprayed with a spore suspension of *Bacillus thuringiensis* Berliner

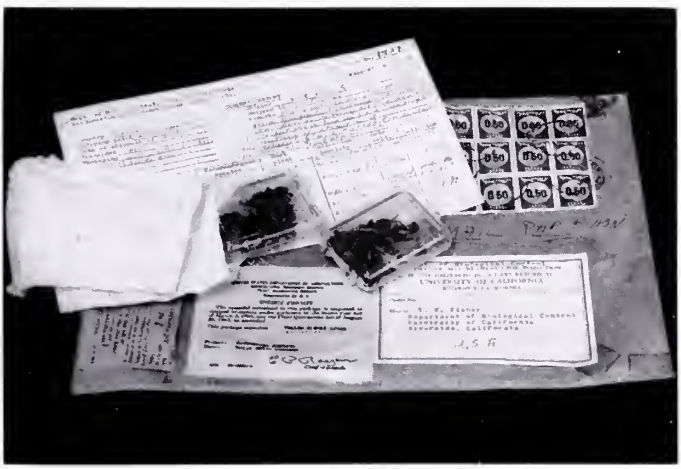
ıe Laboratory of Insect Pathology was ıdded to the Department of Biological ontrol, University of California, in 1944. ıusect pathologists are not numerous, but ıeir ranks are growing and their con-ıibutions to the biological control of in-ɔct pests have indeed been significant.

Methods

It has been mentioned that a major eason for organisms becoming agricul-ıral pests is that they arrive on introduced plants minus their natural enemies. Strict quarantine regulations between countries or states regarding the movement of plant materials and their attendant pests are testimony to the truth of this concept. A parasite-introduction program usually develops in successive stages, namely, importation, mass production and colonization, and evaluation. Each step is summarized as follows:

Importation of Beneficial Insects

Since most of our crop plants are not native—California alone has over 200 commercially grown introduced crops—it has been necessary for explorer-collectors to visit areas thought to be the origin of the crop or the center of distribution of the particular pest species. Relevant information is derived from scientific literature, collection data from museums, and correspondence with entomologists throughout the world. In the area of search decided upon, the collector tries to find infestations of the pest in orchards, botanical gardens, street plantings, private yards, etc. If our pest in its own homeland is under good biological control, it may be extremely difficult



. common method sed by explorer-ollectors in ship-ıent of beneficial ıseets from foreign ountries is small lastic packet sent via air mail

Above, exterior view of recently completed addition to insectary of Department of Biolo-
cal Control, University of California, Riverside, California. New building plus old
are composed of 45 air-conditioned rooms wherein beneficial insects can be propaga
under controlled conditions. *Below*, interior of an insectary room. This room at pres
is utilized for propagating Egyptian alfalfa weevil and its natural enemies

Host plant substitutes used in insectary: banana squash infested with oleander scale used in mass production of *Aphytis*, a parasite of California red scale; citron melon infested with brown soft scale used for production of several parasites of soft scale insects; oranges covered with lint for production of two-spotted mite, laboratory host for predatory mites and insects; potatoes infested with latania scale used for propagation of scale-feeding lady beetles

to find material enough to make adequate shipments home. So, in order to ferret out the organism responsible for the scarcity of the plant feeder, the collector may resort to various techniques of attracting the wanted species to him, such as the use of plants artificially infested with the pest species. Such trap infestations provide a source of adult natural enemies as well as their immature stages. Depending upon the amount of material collected, it may be shipped air mail or air freight in properly sealed and labeled containers (page 9).

Quarantine handling. Because of risks of introducing potential new pests as well as organisms which may attack our native or introduced beneficial species, the procedure of importation is carefully controlled by the U. S. Department of Agriculture. A joint agreement among the U. S. Department of Agriculture, California State Department of Agriculture, and the University of California, allows direct shipment of living foreign insect material to specially constructed quarantine facilities of the University of California where it is handled by personnel especially trained in the quarantine handling of imported insect material. Biological studies in quarantine must ascertain that imported insect-eating (entomophagous) species attack and reproduce only on pest species. They are then ready for the next step in the development of the biological control program.

Mass Production and Periodic Colonization

Mass production. In order to mass-produce economically an insect-eating species, a food chain of three factors must be considered, namely, a host plant or substitute food, a host insect, and of course the parasite or predator.

These three entities are brought together under one roof—the insectary (page 10), which affords controlled temperature, humidity, and light—under the supervision of technicians who have learned some of the habits and peculiar requirements of insects and who can innovate fresh approaches to new procedures of insect propagation.

Because the interior of a building is certainly a far cry from a natural environment, various artifacts are brought into use, particularly in the selection of the host plant. For example, it has been found that many species of pest insects can be cultured on plant materials on which they probably would never occur naturally. For example, sliced potato tubers serve as food for certain cutworms, and whole potato tubers, banana squash, and citron melons make excellent

Bleached potato sprouts (left) used in insectaries for propagation of mealy-bugs for purposes of mass producing their parasites and predators. Green potato sprouts (right) serve as laboratory hosts of certain soft scale insects on which their natural enemies are produced

substitute host plants for many species of hard- or soft-scale insects (page 11). Bleached and green potato sprouts are fine hosts for mealybugs and soft scales, respectively (above), and the growing terminal of a green potato sprout is a highly suitable culture medium for certain aphids. Not all plant-feeding insects will accept an unnatural substrate but, in the interest of expediency, such a course is thoroughly explored because of the several problems involved in handling growing plants indoors. Wherever possible, artificial foods are utilized in the mass culture of the host insect. Propagation of parasites of the oriental fruit fly in Hawaii was accelerated only because a suitable artificial medium was developed for the mass culture of the flies. The addition of protein supplements can greatly increase the fecundity of several species of insects, both plant and insect feeders.

In the mass-culture program the host insect used may or may not be the same species against which the parasite or predator will be released. One example is the tiny parasite of insect eggs, *Trichogramma*, which is being commercially produced at the rate of millions per day (page 13) on eggs of a small grain moth *Sitotroga*. In the United States these parasites may be released in cotton fields where they develop on eggs of the cotton bollworm (*Heliothis*), or in orchards where they attack eggs of loopers (inch worms)or codling moth. One other example is a tiny wasp, *Aphytis,* which is reared in the insectary on species of scale insects different from the field host. The interesting thing is that even after many generations no particular preference for the substitute host is developed.

Periodic colonization refers to repeated releases of beneficial insects throughout a certain period, usually one season. By this technique a constant supply of fresh insects is provided at the release site. This procedure is particularly

richogramma production: each dark egg of *Sitotroga* shown here contains an immature *richogramma,* which upon hatching attack eggs of many species of moths in the field. ards covered with these parasitized eggs are regularly mailed to growers from commercial insectaries

seful in ecological fringe areas, for exnple where natural enemies cannot olerate winter conditions. Achieving esblishment, *i.e.,* permanent addition to ie fauna, is not always a simple matter. actors which enhance the possibility of stablishment include presence of the est in sufficient numbers and stages and imination of antagonists such as ants, ust, and insecticides. Successful establshment is usually not a one-shot affair. herefore, follow-up releases at the same tes may greatly improve the chances or a "take." Finding suitable colonizaon sites, that is, individual plantings r portions thereof which are free of isecticides, is of course necessary. rowers will usually donate test plots, ut many releases of beneficial insects ave been made in backyards and street r park plantings.

Beneficial insects can be anesthetized ith a mixture of carbon dioxide and ther for the purposes of counting, ransferring to new production units, or placing in containers prior to release in the field.

They may be transported from the insectary to colonization sites in pint cartons packed within insulated boxes (below). When high temperatures prevail, cartons of parasites are transported in

Wax paper liner of carton used in transport of beneficial insects is streaked with honey which parasites consume during storage or shipping; shredded wood provides additional resting surface

a prechilled picnic ice chest, and if the trip will require several hours, frozen gel packets in the chest will hold down the temperature. Once they are released, the insects will seek out suitable niches on the plants. In the field, probably the periods of greatest activity are early morning and late afternoon. During the hottest part of the day, parasites or predators will often be found under or between leaves where they are presumably cooled by evaporation as the plant gives off water by transpiration. Not all natural enemies of insect pests are active during the day. Many ground-inhabiting predators are active only at night.

Evaluation of Biological Control

In order to evaluate properly the effectiveness of newly introduced beneficial insects, it is necessary to make prerelease surveys of the pest. Only in this manner is it possible to learn the extent of natural mortality and its cause. Ideally, such information should be available for several previous seasons in order to gain a more exact picture of the situation as it was before injecting new species into the fauna. Following the initial release of the newly introduced species, further surveys are needed in order to assess its role in the control of the pest.

Although it is necessary to evaluate properly the effectiveness of imported beneficial species, it may be of even greater importance to assess the work of our native or previously established species. This can be accomplished by preventing parasites and predators from contacting the host plant by manually removing them, caging branches, applying very light umbrella spray of DDT, or by encouraging ants to run on the infested plant. Any one of these methods will virtually stop the activity of beneficial insects, and the effectiveness can be measured from the resultant increase of the pest and consequent damage. Such information may be used to increase the effectiveness of local species by such means as altering cultural practices, as in strip-treatment with insecticides, strip-planting, or strip-harvesting, as well as providing a basis for augmentation of this fauna by importing other species to plug the gaps in the biological control of a pest.

Economics of Biological Control

The savings to growers resulting from the self-perpetuation of biological control of major insect pests may be projected over subsequent years. In other words, it is easy to calculate the amount that would have been spent for chemical insecticides to control the pest in the continued absence of effective natural enemies. When making estimates of the relative savings of biological versus chemical control of pests, it should be borne in mind that estimates of savings from the former are based on the continued savings that result from discontinuance of insecticide application, whereas estimates of savings from chemical control are based on the net value of the farm produce following insecticidal application which, as a continuing yearly expense, usually is considerably in excess of biological control costs.

Until the development of certain modern insecticides (chlorinated hydrocarbons and organophosphates) there was no satisfactory chemical control for many insect pests. At present, nearly all plant-feeding insects can be controlled, at least temporarily, by various new materials. The drawback is that side effects appear such as development of tolerance to the chemicals so that stronger and more frequent dosages are necessary to bring about satisfactory mortality, and there is concurrent elimination of beneficial insects in the environment, thus permitting the flare-up of minor pests which were previously held in check by biological means. Furthermore, such drastic upsets in natural balance may take several seasons to remedy after alteration of the chemical treatment program. Factors such as these start a spending program which may well be too great for the grower, forcing him to turn to other crops whose pest

problems are not so severe in an attempt to recover his losses as well as to stay in his chosen line of work.

Two recent programs clearly demonstrate the value of biological control to agriculture. Klamath weed, *Hypericum perforatum,* was introduced into northern California where it eventually spread over vast areas of grazing land, crowding out native forage plants and poisoning stock which fed on it. Herbicidal treatment was impractical because of the topography and huge area of infestation. Then, beginning in 1944, through a joint effort of U. S. Department of Agriculture and University of California entomologists, *Chrysolina* beetles, which fed exclusively on this plant, were imported from Australia. Exhaustive tests under quarantine conditions subsequently showed that the insects would not reproduce on or seriously damage other plant species in California. Beetles were initially released in 1953 and today they and other introduced insects specific on Klamath weed have cleaned up several hundred thousand acres of range land in California and neighboring states; forage plants are re-established, and land values have risen. Further, these insects are still dispersing so that in a few years all of the infested area should be under biological control (frontispiece). Since the colonization program was started in 1953, savings from increase in land values plus cessation of herbicidal treatment, plus additional yearly weight gain of cattle, make a conservative total gain up to 1959 of nearly $21,000,000.

The spotted alfalfa aphid, *Therioaphis maculata* (Buck.), was introduced into the United States about 1954. By 1956 it had spread into California alfalfa hay districts and literally threatened to wipe out the industry. Chemical controls alone were too costly and residues at cutting time were too high to permit continuation of that method of control. Team research by University of California entomologists from the departments of Entomology and Biological Control resolved the problem. It was observed that seedling plants were easily killed by toxins secreted by the aphid, so a very light and short-lived dosage of the systemic insecticide, systox, was applied. This kept the aphids from damaging the young plants until they grew large enough to create an environment suitable to the imported natural enemies (three small wasps) and native predators such as ladybird beetles and green lacewing. An additional biological agent was a fungus, which in some areas was a major controlling factor. This integrated control program not only is keeping California hay growers in business but cattle are fed hay free of insecticides.

A considerably less glamorous evaluation of biological control in the United States was published in 1956 by C. P. Clausen, former Chief of the Bureau of Parasite Introduction, U. S. Department of Agriculture, and recently retired Chairman of the Department of Biological Control, University of California. He states, "The results of biological control work in the continental United States for more than 60 years indicate that only a small portion of our most important agricultural pests can be fully controlled by this method and that with a substantial number of them no reduction whatever can be attained. However, most of the biological control projects may be expected to yield a partial control, the benefits derived therefrom being in the form of reduced injury to crops and a lower total cost for chemical and other means of control that still need to be practiced."*

This highly conservative view is an accurate statement of results to 1956, but it should not be assumed that all the possibilities of biological control on all major crop pests had been exploited during the 60-year period, nor had all of those studied received equal emphasis. For example, there has been very little importation work against the ubiquitous codling moth, and the same can be said of the green citrus aphid. Both of these

*Clausen, C. P. Biological Control of Insect Pests in the Continental United States. U. S. Dept. Agric. Tech. Bull. 1139. 151 pp. 1956.

insects are major crop pests where they occur.

Now, let us return to the realm of economics. A successful farmer has to weigh seriously costs of operation, and, since pest control is usually a major expense, he must choose a method calculated to give satisfactory control for minimum cost.

In California there are certain citrus growers' cooperatives which support their own insectaries for the sole purpose of promoting biological control of citrus pests such as mealybugs and black scale. In the 18,000 acres concerned these pests have only rarely required spot chemical control during the past 30 years. The annual cost of controlling these particular pests biologically is between $8 and $10 per acre. In the same growers' cooperatives, chemical control for five other pests under partial or noncommercial biological control averages approximately $40 per acre yearly. In other words, both methods play a vital part in the control of citrus pests in these districts—again, an integrated biological-chemical control program. The important point is that to these growers chemical control supplements biological control.

Another purely economic aspect of biological control is the increasing production of *Trichogramma,* a parasite of moth eggs, not only in the United States but in Europe, South America, and Russia. Cotton growers in the southwestern United States are buying large numbers of these parasites for the purpose of controlling cotton bollworm, *Heliothis* spp. The exact factors responsible for control of this pest accompanying release of *Trichogramma* have not been fully ascertained. One important factor may be that a reduction in insecticide application may have permitted a resurgence of native beneficial insects which, combined with *Trichogramma,* are achieving satisfactory biological control of cotton pests in this extensive area.

An example of commercial exploitation of biological control is the annual spring sale of "ladybugs" by the gallon for control of aphids. Hibernating beetles are placed in cartons and shipped throughout the country. From the biological control entomologist's point of view, the direct benefits derived from this method are rather slight, because the beetles must feed for approximately two weeks before they begin depositing eggs (ovipositing). During this feeding period, newly released adults are quite active, and most will fly away from the release site. It is their growing young that do the best work. Such a program may be feasible if it covers a large enough area, but a backyard or a few acres provide little hope of success.

Limitations of Biological Control

As in other methods of pest control there are limitations imposed upon the biological control of pest insects and weeds. Some are a result of the inherent biological characteristics of the pest and its natural enemies as they respond to environmental stresses, and some are imposed directly or indirectly by man. Combinations of biological and man-induced limitations also occur. With sustained interest on the part of entomologists as well as the public, some of the limitations can be removed.

Natural Limitations

Mentioned elsewhere is the influence of climate on both beneficial and pest species; particularly those which are plant feeders are often better adapted to climatic extremes than are their natural enemies. Therefore, the search for natural enemies of insect pests is designed to cover a wide climatic range within their known distribution, with emphasis on areas with climates similar to that of the proposed area of introduction.

Applied genetics presents the possibility of selective breeding of parasites and predators under conditions of artifically increased extremes in order to permit establishment over a wider portion of the range occupied by the pest.

Lack of synchronization of life cycles of parasites and the pest may occur, particularly with interhemispheric shipments;

or seasonal diapause, as winter or summer dormancy, may be the stumbling block. Another biological factor may be the lack of suitable alternate hosts to carry beneficial species through periods of scarcity of the pest.

Another highly important limitation of biological control of pests is the time required for establishment or re-establishment of a satisfactory natural balance between the pest and its natural enemies. The time factor, following a program of insecticide application, may vary from a few to several seasons. During this period the pest may assume damaging proportions, and it is indeed a far-sighted grower who is willing to "ride out the storm" before the calm. With some of the less toxic materials, and alterations of certain cultural practices, it has been possible to ease into partial or complete biological control of certain major pests.

Man-induced Limitations

Use of insecticides. On any crop most of the potential pests are held under control by natural enemies. Those which are not so controlled may require chemical treatment. In so doing it is probable that the natural enemies of the minor, or potential, pests will be eliminated so that their hosts will assume pest proportions in the absence of natural checks. This has been demonstrated in California on avocados which enjoy excellent biological pest control; growers have found that a little insect damage from no chemical treatment is preferable to opening Pandora's box of added problems by the ill-advised use of insecticides.

Commercial farming. Large plantings, mechanization, etc., are increasingly necessary for profitable farming. However, monoculture over huge acreages does not create a natural, or diversified flora. As a consequence, pests can sweep through and do considerable damage before their natural enemies can catch up with them, and it may be that natural enemies cannot exist in the restrictive environment afforded by this type of planting. In order to produce a marketable crop the grower may treat with chemicals as a stop-gap measure. Too often, however, he may be pressured into treating on an alleged preventive program whether or not a pest problem is actually threatening his crop.

Availability of entomologists trained in biological control. There are not over 40 academically trained entomologists in the United States who are devoting their full research time to the biological method of insect control. This represents approximately 2% of American economic entomologists. Much of the remaining talent is directed toward development and testing of insecticides. Such imbalance is, in large measure, due to the fact that the chemical industries contribute generously to entomological research in our universities and land-grant colleges, whereas funds for basic ecological studies and development of biological control are largely derived from state and federal (public) funds with very little private endowment. Further, new graduates are attracted to industry by higher salaries than can be offered by public institutions. In Canada, on the other hand, the major emphasis is on biological control, and long-term ecological studies have clearly demonstrated that insecticides in the orchard often create more problems than they solve. Canadian entomologists also are making considerable progress in biological control of forest pests.

The consumer. The American consumer has been conditioned to want spotless produce in the market. At our present level of technology, the only sure way to provide such eye appeal is through the use of insecticides or fungicides. Fortunately, the federal Food and Drug Administration has set maximum residue tolerances regarding these materials. Although such regulations are necessary and reassuring, it cannot be denied that the long-term effect on humans of continuous assimilation of even trace amounts of these materials has not been assessed. Not only are insect-free fruits and vegetables more costly to produce but the little

investigated cumulative effects of insecticide residues both in the soil as they may affect future plantings and within the human being are matters of profound importance to us all.

Availability of beneficial organisms. Except for the few commercial insectaries, there is no readily available source of parasites or predators. These will have to come from privately operated insectaries because the beneficial insects propagated at public institutions are for experimental use only and benefits to communities accrue mainly through natural dispersal following the colonization program.

Still in its infancy is the commercial production of insect-attacking bacteria, popularly called "living insecticides." These, as well as a virus which attacks certain caterpillars, have been used commercially with considerable success. These microorganisms attack only insects, and increasing agricultural and horticultural use can be expected.

Human nature. The end result of a successful biological control program is impressive only if the "before" picture is known. Since this form of pest control may be self-perpetuating, new generations of growers often forget why certain insects are no longer problems. One striking example occurred in 1946 in central California when citrus growers used DDT for the control of citrus thrips. There was an immediate outbreak of cottony-cushion scale which approached the severe infestations of the 1880's, because the predator responsible for controlling this pest was eliminated by the DDT. Soon after treatment was discontinued, the vedalia beetle was reintroduced from untreated areas and the former favorable balance was reestablished.

The Role of Biological Control in Future Pest Control Practices

To those who know the subject, the future couldn't be brighter. There are many major insect and weed pests in the United States for which natural enemies can be imported, and thorough ecological studies of most of our major pests and the crops with which they are associated are lacking. It is mainly an inadequate budget that delays progress in these directions.

Now that economic entomologists are fully aware of the speed with which insects develop tolerance for insecticides, there is more universal interest in the role played by natural enemies. One outcome is the development of selective insecticides which are toxic to specific groups of plant-feeding insects or mites and do not appreciably affect other species of arthropods. Another concept is the use of short-lived materials which kill 80 to 90% of the pest, leaving the balance to natural enemies.

In California, integrated or supervised control programs are wholly based on an ecological approach whereby maximum use is made of natural enemies, and minimal amounts of insecticides are employed only if the pest starts to get out of control. Such programs have been worked out for alfalfa caterpillar and the spotted alfalfa aphid with greatly reduced costs of treatment. A cultural technique which resulted in partial biological control included the chemical strip treatment of alternate pairs or rows of oranges in order to permit the build-up of a parasite of purple scale thereby achieving 50% savings for pest control over a considerable area.

In conclusion, I concur with the growing number of economic entomologists who are of the opinion that future pest control programs must be based first on sound ecological studies. Further, such programs will be superintegrated because they will consist of a coordination of applied techniques from the presently independent and largely autonomous methods of pest control as advocated in the fields of legislation (quarantine), mechanical control (traps, barriers), chemical control, cultural control (resistant varieties, trap crops, plowing, flooding, etc.), and biological control.

BIOLOGICAL CONTROL OF SCALES AND MEALYBUGS (*COCCIDAE*)

Some striking instances of control of these serious pests have been achieved

Paul DeBach

AMONG the most common insects found on perennial garden plants, shrubs, and trees are the scales and mealybugs (Coccidae). Common coccids include the armored or diaspine scales, the unarmored or soft scales, the mealybugs, and the fluted scales. Members of each group are shown in the accompanying illustrations (pp. 20-25). Some were also illustrated in the 1955 Handbook on Pests and Diseases (Plants and Gardens 2(1): 19-21, 90, 91.) Many, such as the armored scales, do not fit our picture of a typical insect because of their drastic modifications. Coccids of one species or another occur virtually all over the world and on most species of the higher plants. In the temperate zone they are common and some are serious pests, but the greatest numbers of species are tropical or subtropical. They damage the plant by sucking the sap and sometimes additionally by injecting a toxic saliva. The secretions (honeydew) of mealybugs and soft scales in heavy infestations may serve as a medium for the growth of a black "sooty-mold" fungus, which is unsightly and may interfere with the respiration of the plant. Scales and mealybugs are among the most serious of fruit-tree pests, and on occasion certain ones have seriously threatened an agricultural industry as the cottony-cushion scale, *Icerya purchasi* Mask., did in California in the 1880's before it was brought under biological control by the vedalia ladybeetle, *Rodolia cardinalis* (Muls.), imported from Australia in 1888-89.

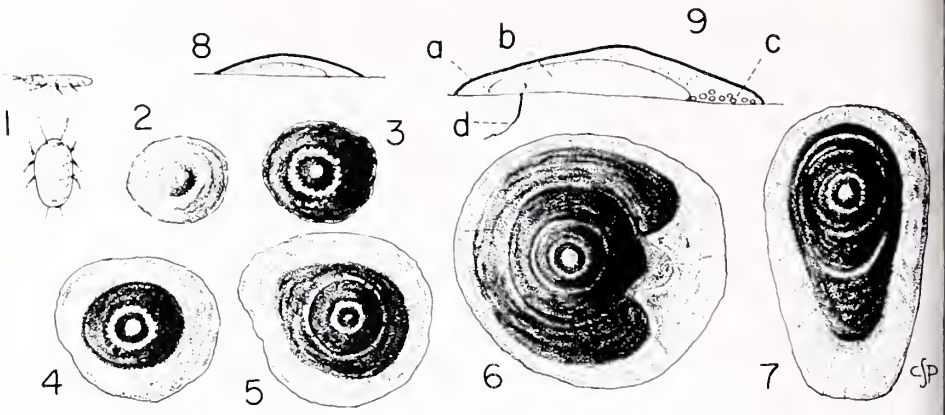
Drawings by C. S. Papp, Scientific Illustrator, University of California Citrus Experiment Station, Riverside.

Natural Control and Its Importance

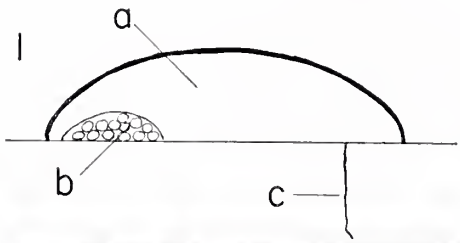
Biological control is often thought of as being brought about by the activities of entomologists in discovering and importing new beneficial natural enemies. This is only a part. Actually, the great majority of the insects around us are under natural control without any help from man. In many cases natural enemies —parasites and predators of the types shown in the illustrations—are responsible for this. Were this not true it is doubtful if we could afford to employ the great amount of chemical treatment which would be necessary. The relatively few exceptions—which may seem to be many to us—are rated as pests. It is important, therefore, to bear in mind that natural enemies of pests are constantly working for us and that we should protect the ones we have.

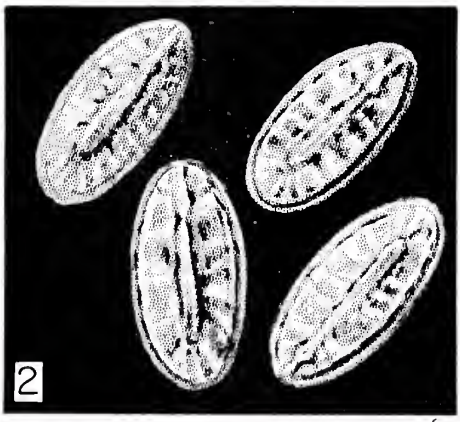
Why a Coccid Problem?

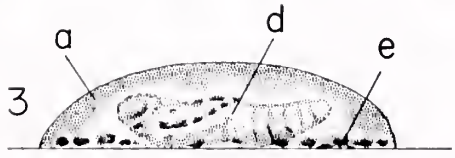
One main reason why coccids are common and sometimes serious major pests in orchards and gardens is that they have been easily and frequently transported on plants from their home country or area to new geographical areas. More frequently than not, their natural enemies fail to move with them, hence the new environment, if the climate is suitable, is without one of the major causes of mortality formerly acting to control them. On a smaller scale the same problem may be brought about by the local movement of isolated plants which originally may bear a few individuals of a coccid but no natural enemies, although these may have been present in the original environs and they would have discovered the new in-



Drawing of armored or diaspine scale showing (1) newly hatched crawler, (2 to 5) growth stages, (6) mature female scale, (7) male scale, (8) longitudinal section of young scale, and (9) longitudinal section of mature female scale showing (a) scale covering, (b) actual body of scale, (c) eggs in space between body and cover, and (d) mouthparts which penetrate plant





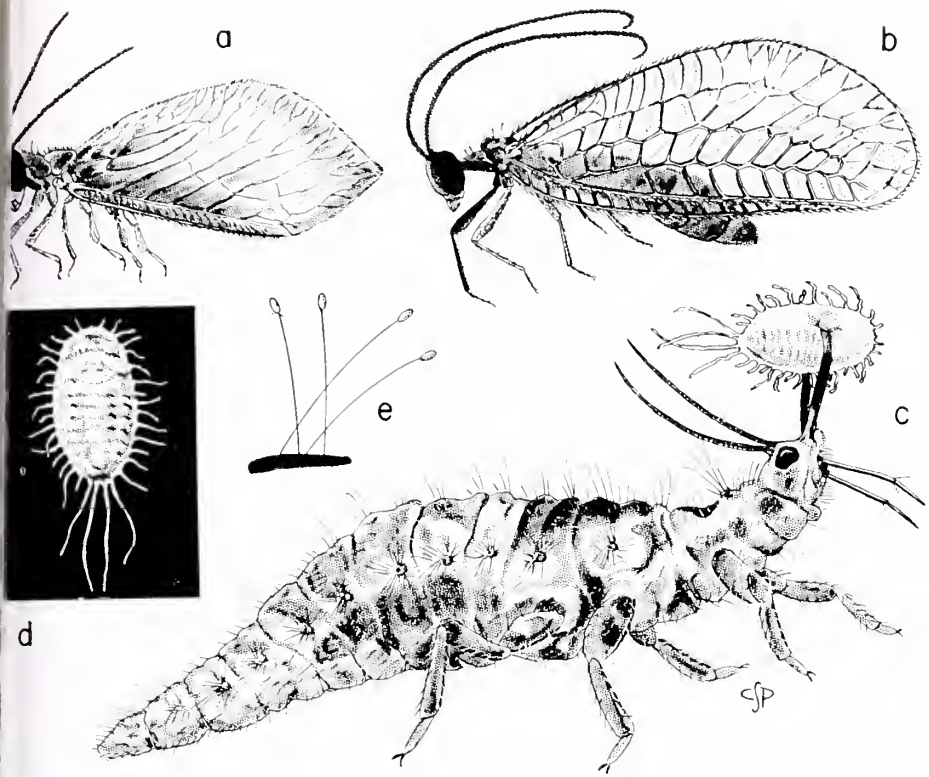


festation before it got heavy. However, the enemies—which often are quite specific in their choice of hosts—may not be present in the immediate environs of the transplanted locale, hence the pest may flourish unchecked for some time.

Biological Control as a Solution

Inasmuch as immigrant pests usually have few natural enemies of any consequence, one obvious solution is to import natural enemies from the home country. Actually, such work has been going on for less than 100 years, and, as already mentioned, the first great success occurred about 1890 with a coccid. Originally, specialized entomologists—so-called foreign explorers—had to "bring 'em back alive" by mule train, ship, or other devious means of transport. Today, with air transport, any point in the world is hardly as much as a week away from our receiving stations. We can now import

Drawing of soft or unarmored scale showing (1-a) actual body of scale which includes cover, (b) eggs laid in space between lower surface of scale body and plant, and (c) plant-piercing mouthparts; (2) dorsal appearance of typical soft scales on plant surface; (3) side view showing (a) scale body, (d) parasite pupa within eaten-out body, and (e) fecal pellets (meconia) deposited by preceding larval parasite stage



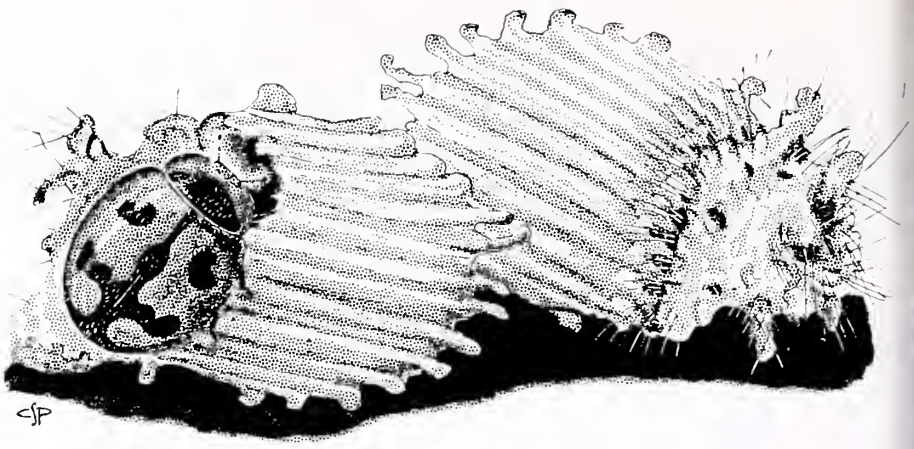
Drawings by C. S. Papp

A mealybug and some natural enemies, (a) brown lacewing adult; (b) green lacewing adult, (c) a green lacewing larva sucking body fluid from mealybug; (d) dorsal view of mealybug, and (e) eggs of green lacewing

and test many more beneficial species much more easily than was the case just a few years ago.

Types of Natural Enemies of Coccids

Coccids have all the types of natural enemies that other insects do—parasites, predators, and diseases. However, few diseases are known and will not be discussed here. For the most part, the parasites are various species of chaleid wasps belonging to the order Hymenoptera. They usually are smaller than the host and many are tiny—less than 1/32 of an inch in length. Virtually all species attacking mealybugs and soft scales are internal parasites, *i.e.,* they lay their eggs inside the body of the pest and the larvae devour its contents, then pupate within the hollow shell or "mummy" as shown on page 20. There are many species in the genera *Aphycus* and *Coccophagus.* The armored scales are attacked by both internal and external parasites. The external parasites lay their eggs on the surface of the scale body but under the scale covering, as shown on page 22. Common internal parasites of armored scales occur in the genera *Prospaltella* (illustrated on page 24) and *Aspidiotiphagus;* common external parasites occur in the genera *Aphytis* (illustrated on page 22) and *Thysanus.* The common predators include lady-beetles (Coccinellidae) of many species (see pages 25 and 27), often rather specific in their choice of prey, green lacewings and brown lacewings in the order Neuroptera (see above), as well as some members of the Diptera (flies) whose larvae are predatory.

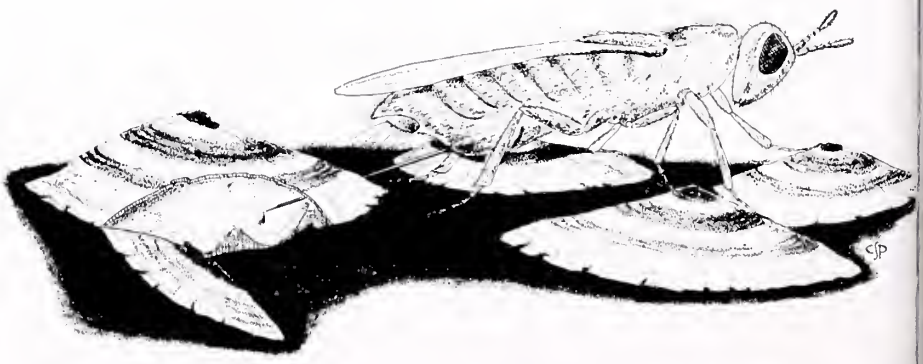


A fluted scale, the famous cottony-scale, with its predator, the vedalia beetle, feeding on i

Cases of Successful Control

Control of coccid pests by the introduction of natural enemies has been attained to a greater or lesser degree with at least 38 species in over 50 different countries. I emphasize again that this does not include the great number of species which never attract attention because they are held under natural biological control. These results are outstanding for one group of pest insects, inasmuch as a survey I have just completed shows that only about 59 additional cases resulting in partial to complete success are recorde among all the other groups of insects In other words, about 40 percent of th successful results obtained have been wit coccids. In California alone several mil lions of dollars each year are saved grow ers by way of reduction in spraying an dusting which followed the introductio of successful natural enemies of scale and mealybugs. On a world-wide basis the savings are truly enormous.

Various explanations have been ad vanced in attempts to explain why suc



Drawings by C. S. Pa

Parasite belonging to the genus *Aphytis* laying eggs on armored scale. Scale covering ha been cut away to show egg being deposited externally on scale body but under coverin

high proportion of successes have occurred with scale insects and mealybugs. Rather than review these different ideas I shall summarize what I believe to be the most logical explanations. First, coccids are more easily transported and established in new areas than many other species. Thus, many introduced pests are represented by coccids, and these are the ones which receive attention. Second, they often attack perennial or fruit-tree crops of great commercial value and frequently are difficult to kill with chemicals. Hence, they have been the object of more than usual attention from biological control workers. Third, they have certain biological characteristics which may make them more amenable to control by natural enemies, such as (1) the perennial host plants on which they usually occur confer a tendency for chronological host-population stability which is advantageous to natural enemies, (2) mass immigration or emigration is not a characteristic of coccid populations—in fact, movement is slight; this also tends to confer chronological host-population stability, and (3) most coccids are exposed in all developmental stages to natural enemy attack. Finally, to the extent that coccids occur in mild climatic areas, there is little climate-induced interruption to natural enemy activity. This, however, would apply to other groups of pest insects as well.

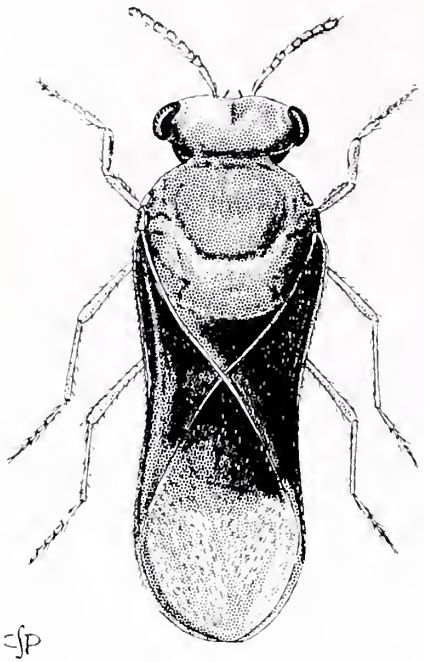
In order to give an idea of the extent of work which has been done on the biological control of scale insects and mealybugs and of the many countries in which some success has been attained, most of the recorded cases are briefly noted in the table, pp. 26-27. The degree of success is not always easy to evaluate. Briefly, complete success is only attributed to complete control of a serious major pest on an important crop occurring over a fairly wide area. Complete control of a pest on a crop or plant of minor economic importance is rated as "partial" as is incomplete control (treatment still necessary but reduced) of a major pest of a major crop.

It will be noted from the table that 23 cases of control were obtained from parasites alone and but 12 from predators alone. Thus, although parasites may seem to be the best bets on the average for importation tests, predators must be tried just as intensively. It is also interesting to note that in most cases one species of natural enemy was so dominant as to be ascribed as the major controlling factor. Briefly stated, the main reason for this is that one highly effective enemy will reduce the host population to a level too low for the others to be of any consequence. This does not mean, however, that in every case the best natural enemy has been found, particularly in those cases rated "partial." There is a wide-open field for continuing and increased effort in biological control. Actually, only a very few pest species have been dealt with more than casually from the standpoint of biological control as compared to the intensive research effort that has gone into other phases of control.

Conservation and Augmentation of Natural Enemies

More and more frequently in recent years we read of "upsets" or "explosions" in pest populations whose natural enemies have been decimated by the widespread or ill-advised use of chemicals. I worked with one, perhaps the first, notable upset from the use of DDT. The enormous use of DDT on citrus in the Central Valley of California beginning in 1945 promoted the cottony-cushion scale (which had been under excellent biological control in California since the vedalia beetle was imported from Australia in 1888-89) from the status of a scarce insect to one of the most damaging pests within the space of two years. From the end of 1946 until the spring of 1947, I was unable to find a single living vedalia beetle in this area. They had to be reintroduced, and, after spraying procedures were changed, the cottony-cushion scale was again reduced by its predator. Meanwhile, many growers suffered serious losses.

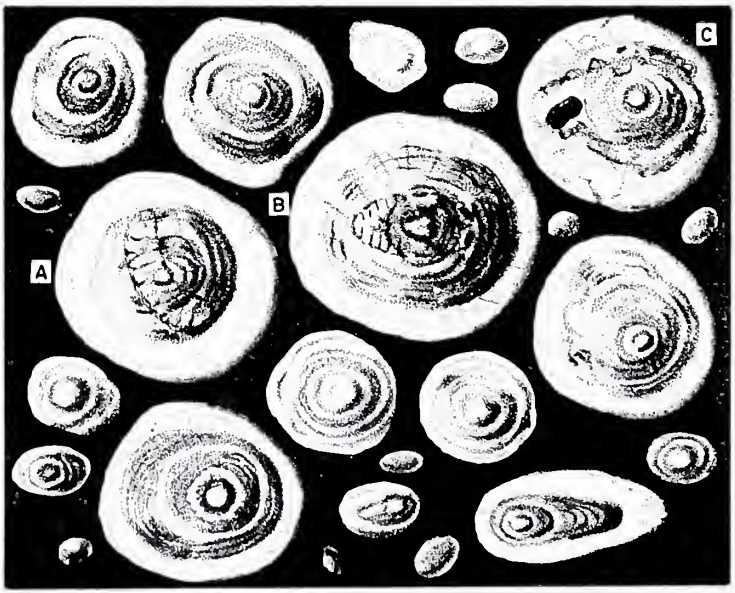
Another factor adverse to natural enemies is dust. Air-borne deposits of road



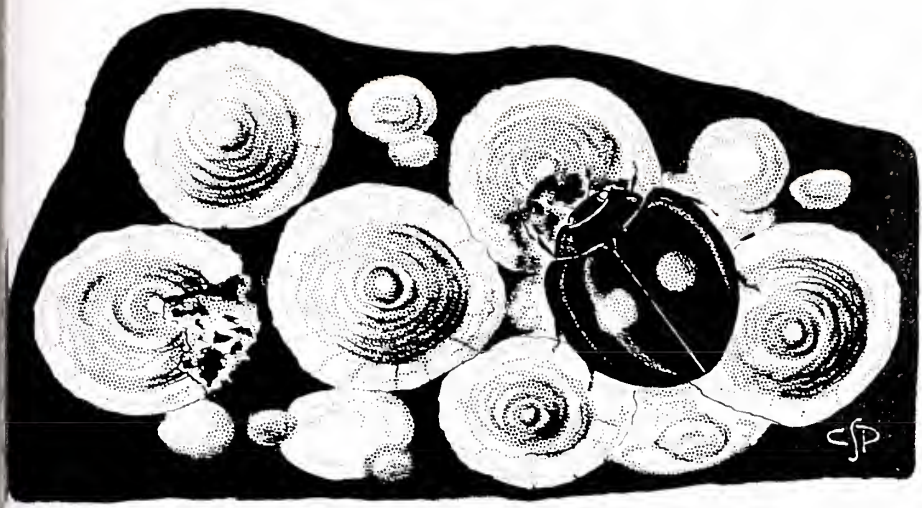
Adult internal parasite, *Prospaltella,* which attacks armored scales

dust on leaf surfaces, for instance, may kill delicate parasites or predators just as readily as many insecticides. Fresh deposits are the most lethal, thus a constant source of dust such as an unpaved road or driveway can be especially detrimental. Weather, of course, may at times be highly adverse to pests as well as to natural enemies. If the natural enemies suffer the greater losses (as often seems to be the case) the pest may rebound to greater numbers than originally occurred, or it may do this each year following cold weather for example.

The gardener can help conserve natural enemies by understanding and, when possible, alleviating the problems just mentioned. An insecticide used without knowledge of what is going to be killed besides one particular pest, is comparable to a human taking pencillin or a sulfa drug without adequate knowledge or advice. Broad spectrum insecticides, *i.e.,* those designed to kill many types of insects, are the most likely to cause upsets in the natural balance. It is preferable to use a treatment designed to kill only the particular pest species it is desired to reduce at any given time. In other words, treat when necessary due to the seriousness of some pest, but not because it is "time to treat." Overdosage should be avoided and materials with short-term



Group of armored scales showing (a) outline of parasite larva feeding inside scale, (b) outline of parasite pupa within scale body, and (c) exit hole chewed by newly transformed adult parasite in order to emerge from parasitized scale



Drawings by C. S. Papp

Twice-stabbed lady beetle feeding on armored scale; ragged, chewed-away portion of scale shows at extreme left

esidues are to be preferred from the tandpoint of conservation of natural enmies. So much is involved in any parıcular plant-insect complex that it is very lifficult to give detailed advice.

Ants can be controlled by various commonly available insecticides. Ones should ıe used which leave no residue on the ılant. This possibly is best accomplished ıy scattering pellets of the new granuated materials on the soil, such as hepachlor, dieldrin, or chlordane granules. 't is not necessary to place these mate'ials around the ants' nests but merely o scatter them over the ground throughıut the area to be protected. Dust is best 'ontrolled by eliminating the source, but f this is impractical, frequent light ›prinkling with water will greatly lessen ts lethal effect upon natural enemies. Heavy dew or rain will produce the same 'esults. The agglomeration of particles ›y water alleviates the adverse effect; t is not necessary to wash off all the dust ›articles.

The garden environment presents some listinct advantages to natural enemies, principally to the parasites and predators naving rather general food (prey) habits, but an adequate source of nectar and proper humidity is good for all. The garden, or any mixed plant association, will support many species of insects to serve as alternate sources of food supply to polyphagous natural enemies. On the other hand, some parasites and predators are highly specialized in their choice of food (monophagous), so if a particular pest species is absent from an area, then its monophagous natural enemy will not occur there. If such a pest species gets a foothold, it may become abundant before the suitable natural enemy finds it. Often the natural enemy may be obtained from the same host insect on the same plant species in another area. Growers and gardeners alike sometimes try to augment the effectiveness of natural enemies by purchasing certain species which have been collected or cultured by commercial operators. Such a procedure should be carefully investigated in order to be sure that the correct natural enemy is being obtained for the particular pest in question and also that the natural enemy is not already becoming abundant on its own. The periodic colonization of natural enemies has much emotional appeal. Be sure each particular case has a good scientific basis.

Table 1.—Cases of successful biological control of Coceidae by *imported* parasites or predators

Species		Host plant	Country	Type of natural enemy	Degrees of success		
Scientific name	Common name				Partial	Substantial	Complete
Aonidiella citrina	yellow scale	citrus	California	parasite		X	
Aonidiella aurantii	California red scale	citrus	California	parasite	X		
Aspidiotus destructor	coconut scale	coconut	Fiji & several other countries	predator			X
Aspidiotus perniciosus	San Jose scale	deciduous fruit trees	California	parasite	X		
Asterolecanium pustulans	pustule scale	shade trees ornamentals	Puerto Rico	predator	X		
Asterolecanium variolosum	golden oak scale	oak	New Zealand	parasite		X	
Ceroplastes rubens	red wax scale	citrus persimmon, tea	Japan	parasite			X
Chrysomphalus aonidum	Florida red scale	citrus	Israel	parasite			X
Erioecoccus coriaecus	bluegum scale	eucalyptus	New Zealand	predator			X
Eulecanium coryli	European plum scale	ornamentals forest trees	British Columbia	parasite		X	
Icerya aegyptiaca	Egyptian mealybug	breadfruit avocado, citrus	Caroline Islands	predator		X	
Icerya montserratensis	a fluted scale	citrus	Ecuador	predator			X
Icerya palmeri	a fluted scale	----------	Chile	predator	X		
Icerya purchasi	cottony-cushion scale	citrus	Calif. & 50 other countries	predator			X
Icerya seychellarum	a fluted scale	fruit and timber trees	Seychelles	predator	X		
Ischnaspis longirostris	black thread scale	coconut	Seychelles	predator		X	
Lepidosaphes	purple	citrus	California	parasite	X		
Lepidosaphes	fig	fig	California	parasite	X		

Parlatoria oleae	olive scale	olive deciduous trees	California	parasite				
Phenacoccus hirsutus	hibiscus mealybug	many ornamental & crop plants	Egypt	parasite		X		
Phenacoccus iceryoides	mealybug	coffee	Celebes	predator		X		
Pinnaspis buxi	a coconut scale	coconut other palms	Hawaii	predator		X		
Pinnaspis minor	cottony-white scale	cotton	Peru	a complex of enemies	X			
Planococcus citri	citrus mealybug	citrus, etc.	California, Chile, Hawaii	1 parasite 1 predator	X			
Pseudaulacaspis pentagona	white peach scale	mulberry etc.	Italy & several other countries	parasite		X		
Pseudococcus aceris	apple mealybug	apple	British Columbia	parasite			X	
Psedococcus citriculus	mealybug	citrus	Israel	parasite			X	
Pseudococcus comstocki	Comstock mealybug	apple	Eastern United States	2 parasites		X		
Pseudococcus filamentosus	Lebbeck mealybug	shade trees etc.	Egypt Hawaii	parasite	X			
Pseudococcus gahani	citrophilus mealybug	citrus	California	2 parasites			X	
Pseudococcus kenyae	coffee mealybug	coffee	Kenya	parasite		X		
Pseudococcus longispinus	longtailed mealybug	citrus	California	a complex of enemies	X			
Pseudococcus nipae	avocado mealybug	guava, fig, avocado, etc.	Hawaii	parasite		X		
Pulvinaria psidii	green shield scale	shade trees	Puerto Rico	predator	X			
Saissetia nigra	nigra scale	ornamentals	California	parasite		X		
Saissetia oleae	black scale	citrus olive	California Peru, Australia	parasite		X		
Trionymus sacchari	pink sugarcane mealybug	sugarcane	Hawaii	parasite		X		

F. E. Skinner

Larva of mealybug destroyer (*Cryptolaemus*) feeding on mealybug

BIOLOGICAL CONTROL WITH LADY BEETLES

These insects are among the most effective agents of biological control

Kenneth S. Hagen

Ladybugs, ladybirds, or preferably lady beetles are known to most people, who recognize them as the reddish or orange colored species with or without black spots.

> "The dainty shell upon backe
> Of crimson strewed with spots of blacke."
>
> Drayton 1630

These insects are found from Alaska to Argentina, from Scandinavia to South Africa.

Besides the larger brightly colored lady beetles of which there are hundreds of species there are a great many that are inconspicuous because of their darker colors and smaller size, but they all belong to the lady beetle family Coccinellidae. This important family comprises nearly 4,000 species in the world, and in North America there are some 370. Of the North American species, 40 species are the typical larger, orange type while the remainder are blackish and usually smaller.

Generally the reddish-orange colored species feed primarily on aphids while the darker species eat scale insects, mealybugs, white flies or spider-mites.

When the prey are scarce, nearly all the lady beetle species turn to other sources of food. Honeydew, extra-floral nectary secretions and pollen are favorite foods at this time. Some will even nibble on flower petals. There are, in addition, some members in the coccinellid family that live strictly on plants. The Mexican bean beetle, a large greyish-brown beetle with black spots, is a pest of field and garden beans in many states. Fungi and powdery mildews make up the diet of the tiny ashy-grey lady beetles that belong to the *Psyllobora* group.

Some lady beetles are very specific as to what insects they will eat and some species are so fastidious that they are even limited to a particular stage of an insect pest. Recently in Czechoslovakia an entomologist found that when a certain lady beetle ate a specific aphid on a specific plant it would be poisoned, but another lady beetle species could eat the same aphid on the same plant without harm. However, many of the aphid feeders in particular will prey on most any aphid species and on eggs of moths.

Some coccinellids are found associated only with trees while others prefer low vegetation, and others seem to wander between these two habitats. Movement from meadow to forest and from valley to mountain periodically occurs in a few species.

Lady beetles that migrate rather long distances between habitats are very difficult to establish locally by man in his efforts to promote the control of pest aphids by such means. On the other hand, many lady beetles that prey upon more stationary host pests have been introduced into new environments quite successfully.

Introduced Lady Beetles

Lady beetles have played a significant role in the development of biological control. The introduction of the vedalia beetle into California during the 1880's from Australia saved the citrus industry in California by controlling the cottony cushion scale which could not be checked by any other method. This project was so striking that entomologists around the world considered that such a control method might be employed against any insect pest.

Many attempts were made to introduce other exotic parasites and predators, among which were many lady beetle species, to control aphids, scale insects and mealybugs. Most often the introduced lady beetles did not become established in the new environment. Some species showed promise but failed to survive in an adverse season. This led to the culturing of large numbers of lady beetles in insectaries and releasing them into the field at the appropriate time. The first natural enemy to be manipulated in this manner was the mealybug destroyer *Cryptolaemus montrouzieri* (see page 51).

This blackish, hairy beetle with a reddish thorax and wing cover tips was introduced into California to prey upon mealybugs infesting citrus. It controlled mealybugs in a small belt along the coast, and it would spread out during the summer over a wider area but winter conditions would almost eliminate it. Various counties in southern California, as well as citrus grower organizations, set up insectaries to produce very large numbers of this species during the 1920's. Today millions of *Cryptolaemus* are still being produced and released in the citrus areas. It was found that this lady beetle would also control mealybugs in greenhouses, but recolonizations are necessary even here, for the beetle depresses the mealybug populations to such low levels that beetles subsequently starve.

Native Lady Beetles

Many of our native lady beetle species naturally control aphids, scales and mealybugs in our wild areas, crops and gardens with no human effort being required. Thus, spectacular biological control of aphids can be seen nearly every spring in grain and alfalfa fields in the West. It is no wonder that many growers and gardeners want to collect or buy lady beetles to release against aphids, in

Adult convergent lady beetle, *Hippodamia convergens*

the hope of increasing the benefits from these voracious little predators.

The California State Department of Agriculture during the early 1900's initiated a program of supplying lady beetles free to growers. Collectors were sent into the Sierra Nevada canyons to gather the convergent lady beetle (*Hippodamia convergens,* see above) which gathers in great masses in western mountains. Tons of these beetles were collected during December and January and placed in cold storage. During the spring any grower could request 30,000 beetles free of charge for every ten acres.

This program continued for over five years until an entomologist critically studied the results from such releases. He marked beetles with paint and found that the majority of beetles flew out of the fields where they were released, regardless of whether they were liberated during the day or night and regardless of how many aphids were present. Similar tests were conducted in various grain fields and orchards which were infested with aphids. In all cases no more than ten per cent of the beetles would remain in the field where released, and this was not sufficient to give control. Many growers claimed good results from the releases, but probably in most cases the control came from local, naturally occurring beetles which were migrating into the fields during the spring.

Since that time, other entomologists including the author, have experimented with *H. convergens* by releasing marked beetles in various crops and the results obtained were found to be similar to that reported earlier. However, private individuals for years have been collecting the convergent lady beetle from mountain aggregations and selling them to farmers and gardeners. Some of the collectors sell as many as 10,000 gallons a year. There are over 75,000 beetles per gallon.

The convergent lady beetle in California begins its migration from the valleys to the mountains during the middle of May and remains more or less quiescent until the following February or March. During the nine months the beetles are in the mountains they can be found aggregating in colonies. These aggregations shift during the year from alongside

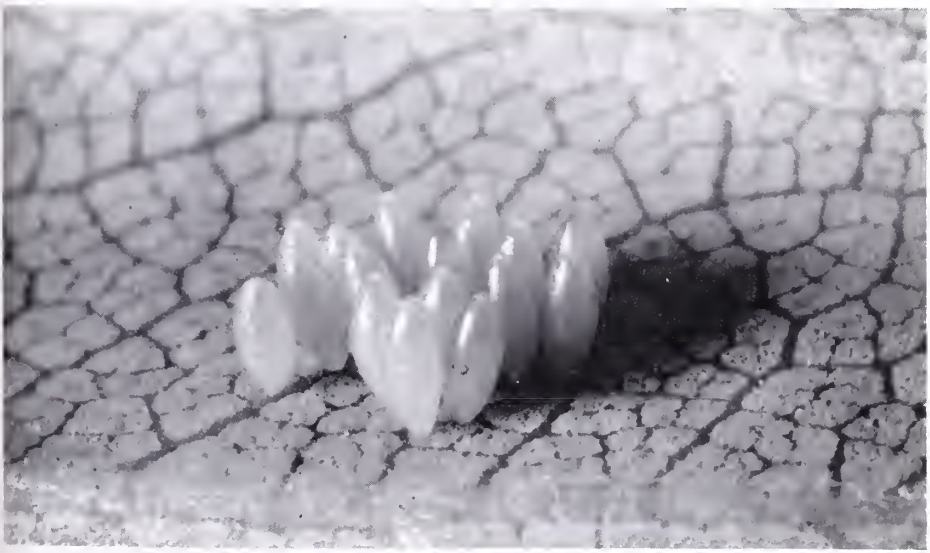
creeks during the summer to higher ground during the winter. The beetles do very little feeding but do take in water. They exist largely on the huge amount of fat that they stored before forming these colonies.

It is important to point out some of these details in order that the behaviour of beetles when taken from the aggregations can be understood. The author has found that if *H. convergens* is collected from the mountain aggregations during the summer and released against aphids infesting crops such as alfalfa these beetles do not fly out of the fields immediately like those released during the spring. To the contrary, the beetles remain in the field and may even form aggregations in the fields where released. However, very little feeding on aphids occurs because of a reduced appetite associated with the amount of fat that has been stored, for they naturally subsist on their fat if present.

In these release tests, the summer collected beetles were unable to prevent rather low aphid populations from attaining injurious densities. In order to cope with an increasing aphid population the beetles must eat enough aphids to produce a generation of young which would then be present in greater numbers. Since the presence of high levels of fat stimulated little feeding in the adults, and since this stored fat appears to be effectively unavailable for the production of eggs, very little of this needed reproduction occurs.

Thus, until methods are developed that will either prevent the flight of the beetles released during the spring, or force the summer beetles to utilize most of their fat before being released, there is little value in releasing the convergent lady beetle collected from aggregations.

One method to make full use of naturally occurring lady beetles in crops and gardens is the use of a proper insecticide. If an insecticide must be used to control any pest, then we should use the material that is least harmful to natural enemies. In other words, use a selective insecticide. If a non-selective chemical is used the pest may be temporarily controlled but a resurgence (outbreak) of this same pest, as well as other



Photos F. E. Skinner

Eggs of aphid-feeding lady beetle (*Hippodamia*)

pest species, will usually result, and repeated applications of insecticides may be required.

Another point of importance is the influence of ants. Ants tending aphids, scales and mealybugs on plants will disturb the natural enemies. Thus, controlling these insects is important. Perhaps baits are best for ant control because there is less chance of disturbing other organisms.

In the field or garden, the immature stages of lady beetles can be observed, and should be recognized so they will not be destroyed. The following notes describe some of the immature stages.

Aphid Feeders

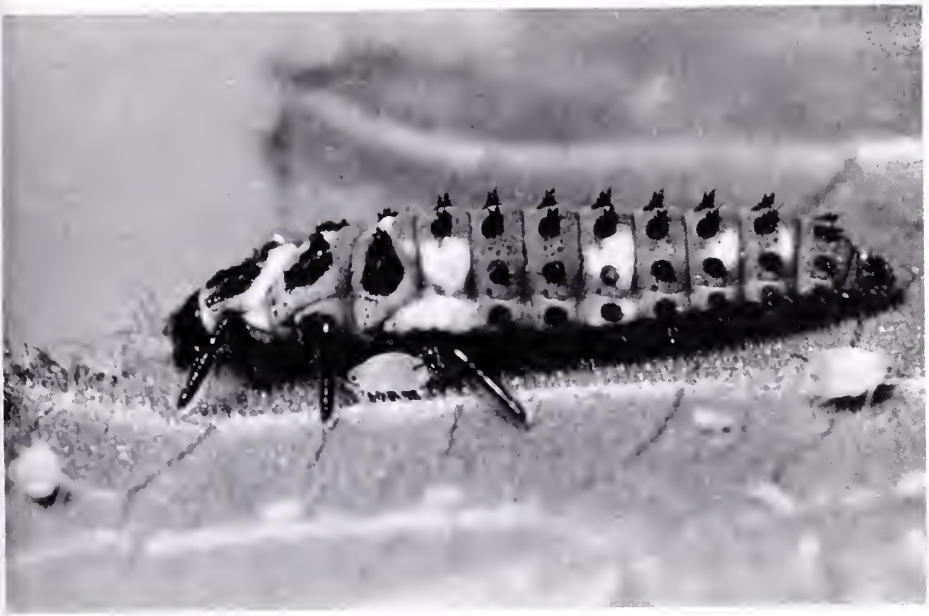
In the garden or in the field on almost any plant where there are aphids, you may find a cluster of yellowish or orange eggs standing on end (page 31). Clusters may have from 5 to 50 eggs, and are usually found on the under surfaces of leaves. Adults at times lay their eggs near the bases of plants under loose objects lying on the soil or even on wooden objects near aphid infested plants. A convergent lady beetle, during her life-time, has deposited up to nearly 2500 eggs in our laboratory. During warm weather the eggs begin to hatch in about 3 to 5 days, and the tiny black larvae can be seen clustered around the egg shells.

The young alligator-like larvae are dark and have no conspicuous markings. Their first meal may be one of the eggs in the cluster that has delayed in hatching. Feeding on an egg provides enough energy for the young larva to range twice as far as one that did not have this initial feeding. In a few days the young larva has grown some and molts, leaving its shed skin attached to a leaf or stem. As the larva (page 33) matures its short spines become more prominent and colored markings begin to appear. After three molts, during which time it has eaten as many as 300 to 400 medium-sized aphids, it forms a pupa (page 33). This resting stage is black with some reddish markings, and is usually found on the upper leaf surface with the head pointing down.

As the mature larva prepares to pupate, it is vulnerable to attack from other larvae. Cannibalism is common if aphids have become scarce. In about five to seven days after pupation the adult beetle emerges from the pupa. A whole cycle generally requires about one month from egg deposition to adult emergence during the spring. This period is shorter during the summer.

The newly emerged female must find aphids in sufficient quantity in order to produce and lay eggs. Usually around 200 to 500 medium-sized aphids are required for the first eggs to be produced. Most species mate several days after emergence and often remating can be observed. Mating is necessary to obtain fertile eggs. Upon emergence, if no aphids are available, the beetles may turn to other types of food, as already mentioned, or migrate. *Hippodamia convergens* will migrate many miles to surrounding hills or mountains and form aggregations, returning to the valleys the following spring, but if sufficient aphids are found a new generation will be produced in the valleys.

Other species, particularly types that are very convex and belong to the genus *Coccinella*, will enter a dormant state whether aphids are present or not, for the aphids they eat are converted to fat and not directed toward egg production. Therefore, these beetles are of little value in controlling aphids in gardens or fields during the summer months after their first spring generation. However, since some species may produce one generation after another, it is important to remember that at least some aphids must be available in order to promote reproduction. This also applies to other natural enemies. There must be some aphids present to keep the lady beetles around and reproducing. This is the reason why chemical treatments of low aphid populations can reduce or eliminate the natural enemy activity for long periods of time.



Larva of aphid-feeding lady beetle (*Hippodamia*)

Pupa of aphid-feeding lady beetle (*Hippodamia*)

Photos F. E. Skinner

Adult of scale-feeding lady beetle (*Chilocorus*)

In the fall some species of lady beetles that are not active during the summer (estivating) begin to feed on aphids again and deposit eggs. Often good aphid control results. But if the weather is too cool it slows down the beetle feeding though it may not be cool enough to stop aphid reproduction. Thus, the aphid population slowly increases and may eventually attain damaging levels.

Scale Feeders

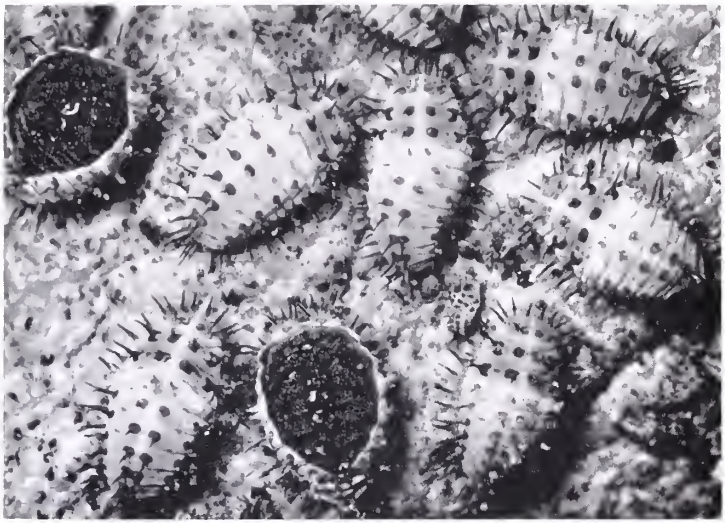
The scale-feeding lady beetles are nearly always black with some reddish spots. The common species have two red spots on their shiny helmet-like wing-covers. These species are called the twice-stabbed lady beetles (*Chilocorus* spp., see above). Some scale feeders are smaller without spots.

The eggs of *Chilocorus* are usually hidden, either being deposited beneath the armour of a scale that has been eaten or in bark crevices. The oval eggs are yellowish or reddish, usually single and lying on their sides. The larvae, hatching from the eggs in about ten days, are greyish with black spines. Scale crawlers or young settled scale insects are required as food, for the young larva cannot cope with the larger stages. The larvae (page 35) shed their skin three times while they are growing, and are quite distinctive in being armed with long branched spines. The pupae (page 35) are formed within the last larval skins which are widely split down the middle, and are to be found on tree trunks and branches. Some scale eaters confine their feeding to the small flat disc-like (diaspine) scales while others prefer the larger, convex, soft scales. These beetles are mainly arboreal and require fairly heavy scale populations to support them. It takes a little over a month for a generation to develop. The adults in the late fall hibernate under bark or other protected places in trees.

Several species of scale-feeding coccinellids have become established after introducing them from foreign countries.

Mealybug Feeders

The lady beetles associated with mealybugs are usually dark and small and many are covered with short hair (*Scymnus*) while others are shiny with small red, orange or yellow spots (*Hyperaspis*). These beetles work among the mealybugs and are often overlooked because of their size and the waxy exudations of mealybugs that cover them.



Larvae and pupae of scale-feeding lady beetle (*Chilocorus*)

Photos F. E. Skinner

These beetles usually deposit their eggs among the colonies, often in the mealybug egg masses or at least near the mealybugs. The larvae of many species are covered with white waxy filaments or plates projecting from their dorsum and sides and they resemble mealybugs themselves. But if the larva is turned over the resemblance disappears, for the beetle larva has a dark and distinct head region while the mealybug when turned over exhibits only long thin stylets (sucking mouth parts) that originate from the forward region of the body. A *Cryptolaemus* larva (see page 28) resembles the larvae of many other mealybug feeders except that it is larger. There are three larval molts in most species. Several species have been successfully introduced into North America.

Other Insects Attacked by Lady Beetles

There are a few small lady beetle species that feed on spider mites. They are tiny black beetles (*Stethorus*) that lay their small oval, cream-colored eggs among mite colonies and on the under sides of leaves. The larvae are hairy and brownish with black markings. The larvae as well as the adults eat mites. When the larva matures it forms a black pupa on a leaf. A related group of small beetles have species that feed on white flies and psyllids.

Conclusions

Lady beetles are important natural enemies of aphids, scale insects, mealybugs and spider mites. They often effectively control these pests, although some aphid-feeding lady beetles are not active during the summer, when aphids may become abundant. Releasing the mealybug destroyer is of value in controlling mealybugs in citrus trees and in greenhouses. However, purchasing the convergent lady beetles that are collected from aggregations is of little value in controlling aphids when released. When liberated during the spring they fly out of fields. When released during the summer they do not feed or reproduce at a high rate. If an insecticide is used against any pest, choose if possible a selective insecticide that spares natural enemies and least disrupts the natural balance, and only use an insecticide when the pest approaches damaging numbers. Control ants.

Photos on this and four following pages from movie "Battle of the Bugs" by Ken Middleham

Remarkable photograph of rose aphid (*Macrosiphum rosae*) giving birth to living young

NATURAL ENEMIES OF APHIDS

Fortunately a large number of plants and animals attack these small pests

Evert I. Schlinger

APHIDS are one of man's most common pests. There are hundreds of different species that feed on stems, leaves, flowers, buds and even roots of plants. They reproduce at phenomenal rates and have many generations each year. Many are quite specific to one or several plant species, while others enjoy feeding on many different and unrelated plants, at least for part of the year. Fortunately, most species of aphids have a number of natural enemies which are always ready to attack and subdue them. There are some environments where aphids do not have enough species of natural enemies available to control them, and these are considered pest species. It is for these species that work in biological control is most promising, and once the native home of the aphid is discovered, its natural enemies can be collected and sent to the region where the aphid is a pest. The satisfactory establishment of these natural enemies ultimately results in a much better balance of nature and often the species is reduced from an important pest to one in the "rare" category. The three main groups of organisms which prey or live upon aphids are parasites, predators, and diseases.

Aphid Parasites

There are two families of hymenopterous* insects which contain parasites of aphids—the Braconidae and the Aphelinidae. Both groups are tiny wasps (¼" to 1/16") which are solitary, internal parasites. Common genera of parasites are *Aphidius, Ephedrus, Praon,* and *Trioxys* (Braconidae), and *Aphelinus* (Aphelinidae). Altogether there are about 200 known species of parasites, some of which attack only one species, and some of which as many as 30 different species of aphids. Each female wasp (depending upon the species) is capable of killing 150 to 500 aphids. This is accomplished by inserting a single egg inside each small aphid encountered. The minute egg hatches in two or three days and the tiny wasp larva begins to feed on the aphid's fat tissues. After several larval molts during three or four days of feeding, the larva cuts a small hole in the aphid's venter and cements the aphid to the leaf with silk. The parasite cocoon is spun either beneath or inside the aphid and after five or six days of rest in the pupal stage the tiny wasp cuts a circular hole in the dead aphid skin and emerges. Mating takes place soon after emergence and another parasite generation is started. Depending upon weather conditions, a parasite generation may be completed in as short a period as 10 or as long as 40 days.

Effective parasites are well synchronized with their particular aphid hosts, so much so that when aphids lay eggs in the fall of the year to carry the aphid species through the cold winter months, the parasite enters a "diapause" or rest-period condition. The parasite "sleeps" through the winter inside the cocoon as a mature larva, and may rest from three months to a year in this condition depending upon the weather. In the spring, when the aphid's eggs begin to hatch, the diapausing parasite larvae pupate and adults soon appear on the scene to attack the first generation of aphid hosts. Parasitized aphids can be differentiated from unparasitized ones by the swollen, white, black or brown dead aphids, often referred to as "aphid mummies." Adult parasites do not feed on aphids but may be observed feeding on plant nectars or aphid honeydew.

*Insects belonging to the order of wasps, bees and ants; see page 44.

Several melon aphids parasitized by *Aphidius testaceipes* and cemented to leaf. Note circular wasp emergence holes in the "aphid mummies"

Adult convergent lady beetle (*Hippodamia convergens*) feeding upon rose aphid

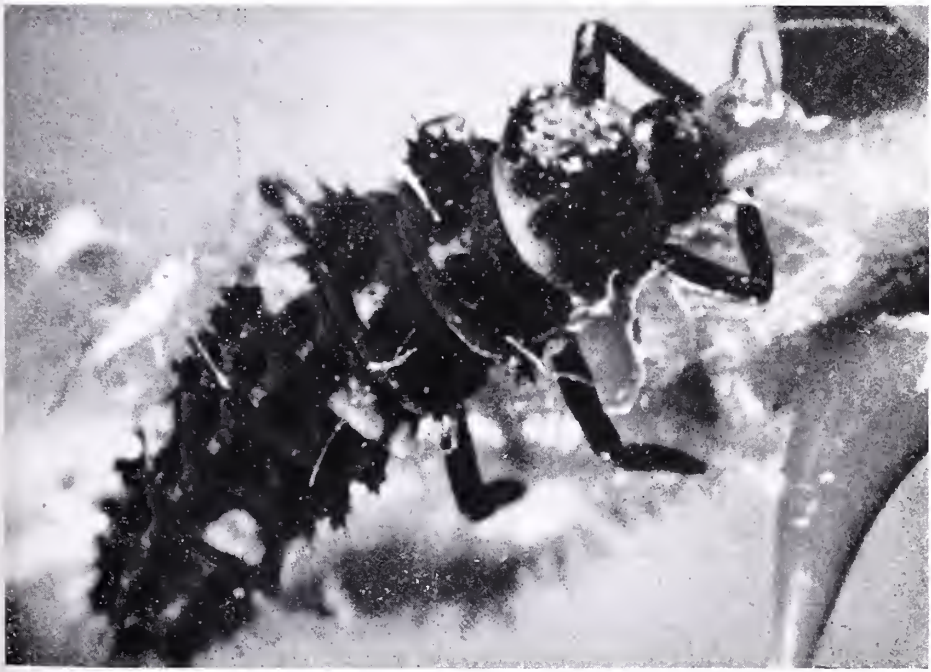
Aphid Predators

Predators of aphids can be distinguished from the parasites by their larger size (¼″ to ¾″), and because a single predator may devour up to 1000 aphids during its lifetime. Predators of aphids are found in several orders of insects—Coleoptera, Diptera, Neuroptera, and Hemiptera. Other important predators include certain species of spiders and mites.

Perhaps the commonest and best known of all aphid predators are the many species of lady beetles (lady bugs). The yellow-orange eggs of these beetles are laid in small groups on leaves of plants. The "alligator-like" black and yellow or orange larvae are quite noticeable and very active in seeking out their aphid prey. The larvae commonly pupate on the plant parts, and the pupa (although stationary) exhibits an interesting protective trait of jerking back and forth when disturbed by another organism. Adult lady beetles often live a full year and may move from plants on one area to plants in another area many miles distant during their lifetime. Perhaps the most common and best known species is *Hippodamia convergens,* the convergent lady beetle (order Coleoptera).

Another common, but more secretive aphid predator is the green lacewing larva (*Chrysopa* species, Neuroptera). The eggs of the lacewing are each laid on top of a long egg stalk on leaves of plants. The young "aphid lions" with their long, sickle-shaped, sucking mandibles, may consume several hundred aphids before they pupate inside a round, white silken cocoon. The adult green lacewings are delicate and green in color. They feed mostly on plant nectars and aphid honeydew, but adults of some species also eat aphids. (See page 21.)

Adult convergent lady beetle depositing eggs on leaf



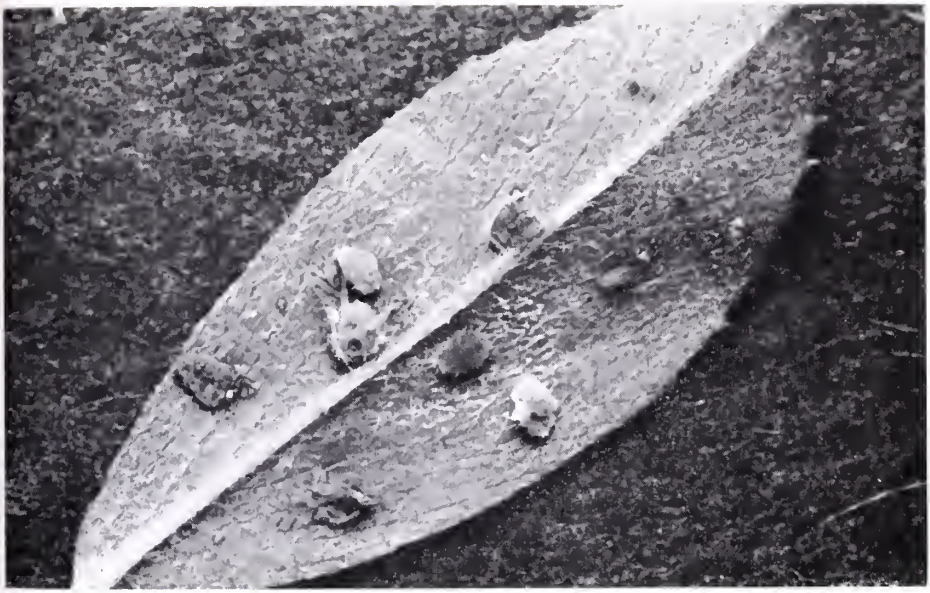
Alligator-like larva of convergent lady beetle feeding on young rose aphid

Common "aphis-lion" feeding upon young aphid. Note sickle-shaped mandible inserted into aphid

The syrphid or hover flies (Diptera) constitute another important group of aphid predators. The yellow or white and black flies are often observed in the spring hovering in the air above aphid-infested plants—hence their name, "hover flies." The tiny white eggs are laid singly among the aphids and the green, legless larvae feed voraciously on hundreds of aphids before transforming into hard, brownish pupae. The adult flies feed on plant nectars and aphid honeydew.

Other less common predators of aphids include larvae of *Leucopis* flies (Diptera), larvae and adults of certain rove beetles and *Collops* beetles (Coleoptera), certain

Adult hover fly resting on leaf prior to laying eggs which will hatch into larvae that feed voraciously on aphids



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Dead spotted alfalfa aphids (*Therioaphis maculata*) killed by a fungus disease, *Entomophthora exitialis*

assassin bugs, nabid bugs, *Orius* or flower bugs, certain mirids, and the big-eyed bug (all Hemiptera), certain spiders such as *Erigone* and *Eperigone,* and some mites of the chigger family, Trombididae, and the family Anystidae.

Fungus Diseases

There are about 15 known species of fungi which attack aphids. All of these species belong to the genus *Entomophthora* (= *Empusa*). The species are differentiated by the size and shape of their minute hyphal bodies, conidia and different types of spores. Aphids affected by fungi are flattened, fuzzy, and brown, black or white in appearance. Some species of fungi may destroy large numbers of aphids in a short period of time when weather conditions are right.

How Biological Control Works Against Aphids

The cumulative effect of parasites, predators, and diseases can be disastrous to even heavy aphid populations of species which are "liked" or preferred by their natural enemies. Other species of aphids which are not "liked" by their enemies can remain uncontrolled in the presence of all kinds of natural enemies. This explains why at certain times of year on particular plants a given aphid species may be completely controlled biologically, while another aphid species on a plant nearby may remain uncontrolled.

Effective parasites can control their host aphids at very low (noneconomic) populations, while predators and diseases operate best when aphid populations are somewhat more abundant. Fortunately, all three groups of natural enemies work together quite efficiently in controlling aphid outbreaks.

Recent Biological Control Projects

If a given aphid species does not have effective natural enemies in this country, it is the job of biological control people to determine the native home of the pest aphid and send a foreign explorer to that country to observe, collect, and send back to this country all the natural enemy species he can locate.

The first successful attempt to control aphids by biological means was through

Middleham

Giant vacuum collecting machine designed to collect large numbers (millions) of imported parasitic wasps which attack the spotted alfalfa aphid in California

the use of an imported wasp, *Aphelinus mali,* on its host, the woolly apple aphid (*Eriosoma lanigera*). This parasite was so efficient in the original trials for its establishment that more than 20 countries have utilized this wasp and reported great success.

In 1955, a year after the spotted alfalfa aphid (*Therioaphis maculata*) was accidentally introduced into the United States from the Middle East, three species of parasites were collected and sent to California for propagation and colonization. The success of this biological control program was striking, and one of the main factors responsible for the rapid colonization of the parasites was the development of a giant vacuum sweeping machine. This machine collected millions of field-reared parasites in a short period of time with minor expense, and these parasites were transported and established throughout California during a one-year period. Perhaps five or ten years were saved by distributing the parasites in this manner.

The recent importation and establishment of a parasite from India on the pea aphid (*Macrosiphum pisi*) has also been successful. This large *Aphidius* wasp parasite can now be found in many parts of California controlling a heretofore serious pest of alfalfa.

The importation in 1959 of a small French *Trioxys* wasp parasite of the walnut aphid (*Chromaphis juglandicola*) has been accomplished in California and preliminary results of this program look very promising.

During 1959 and early 1960, parasites of the green peach aphid (*Myzus persicae*) were sent in for propagation from the Middle East. Although it is too early to know if these will become established, they are being reared satisfactorily and releases of the parasites are being made.

Investigations are under way on many aphid pests, and recently it was concluded that foreign exploration for natural enemies of the rose aphid (*Macrosiphum rosae*) and the green citrus aphid (*Aphis spiraecola*) is greatly needed. Biological control of aphids is in its infancy, and it would seem to be just a matter of time before many more pest aphids will be put back into balance with nature by importing and establishing their specific natural enemies.

MANTIDS

The ever-interesting preying mantises

Alexander B. and Elsie B. Klots

There are some 1800 species of Mantids but only a few of these are found commonly in the United States. The small native *Stagmomantis carolina,* about two inches long, is common in the southern states as far west as Arizona. Several other species are known in the southwest especially in the more arid regions. The European *Mantis religiosa,* introduced near Rochester, N. Y. about sixty years ago, is common in New York and New England. The most frequently seen species in the East, however, are the Chinese *Tenodera sinensis* and *Tenodera angustipennis.*

Gravid female mantid (*Mantis religiosa*)

Mantid egg cases may be purchased and attached to trees and shrubs about the garden. The chief benefit to be derived from this, however, is the feeling of virtue one has in believing one has established a highly beneficial insect that will protect the neighborhood by destroying many harmful pests. Of the thousands of young mantids that come tumbling out of a case, perchance a few will survive. With avid appetites and rapacious front legs they will capture many insects, including some of their own brothers and sisters. Some of the insects they catch for their own delectation will be harmful species, but just as many more will be species that do no harm and a few may be even beneficial.

Nevertheless the Mantid is a handsome insect. It is an interesting one to have around. So, by all means, let us continue to protect it and to encourage our neighbors, and their small children to do the same.

Author photos

Young Chinese mantids leaving egg case

BENEFICAL BEES, WASPS, AND ANTS

These well known insects play an important role in the balance of nature

Alexander B. and Elsie B. Klots

THE insects of the Order Hymenoptera (the bees, wasps, and ants) are well known to gardeners. Many of them are heartily disliked for the painful contact they occasionally make with us, but they are tolerated because of their importance in the cross pollination of flowers. However, let us suffer them gladly for other reasons also: the bees and wasps for the indirect benefits which they confer upon mankind in the control of many plant pests, and the ants for their great contribution in working the soil.

The insect population of the world, when undisturbed by man, maintains remarkable balance and orderliness. Excessive increases in numbers of any given species are normally held in control by natural means. This natural control may be by diseases or by the selective activity of predators and parasites. Important among the predators and parasites are many species of bees and wasps.

The difference between a predator and a parasite is not always clear cut. A predator lives at the expense of another living creature, typically killing it by violence and devouring its vital tissues. The relationship, at least as far as the attacker is concerned, is temporary, for the predator normally preys upon a series of individuals.

A parasite, on the other hand, feeds upon the body of another individual without killing it. In many cases, as with mosquitoes and black flies, the relationship of a parasite to its host is also a fleeting one; whereas with lice and fleas it is more or less permanent. Most insect parasites are external (or ecto-) parasites; they are also obligatory parasites because they are limited to that type of existence. Relatively few are internal and many of those are not limited to that type of existence, hence are called facultative.

The chief, true predators among the Hymenoptera are the paper wasps, *Vespula* and *Dolichovespula*, and the imported European *Vespa crabro*. Though most of us do not care to have them or their large papery apartment houses around, we must recognize the fact that they kill and chew up many, many insects, the majority of which are probably harmful. So *Vespa crabro* is not the unmitigated blackguard some gardeners would have us believe.

Other Vespoids, such as the potter wasps, *Eumenes*, and the burrowing wasps, *Odynerus*, consistently stuff their nests with paralyzed caterpillars. Most of the Sphecoids (digger wasps, mud daubers) appear to be actively predaceous hunters, especially upon Diptera and the larvae of Lepidoptera. But at once it becomes apparent that their behavior is not that of a simple predator that goes out to kill and eat an insect. Some furnish the nest in which they place their eggs with up to a dozen or so paralyzed insects for their young to feed upon; but some of the mud daubers and the Bembecidae may undertake the more taxing technique of progressive provisioning, which means daily providing their growing young with numbers of freshly killed insects. But whether the capture is consumed immediately, whether it is carried home to the growing offspring, or whether

it is laid aside for the future use of another generation, these are all examples of varying degrees of predation.

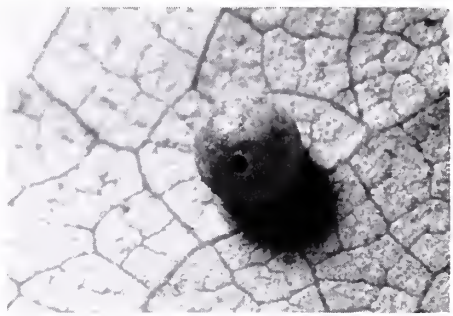
It is only a short step, sociologically speaking, to the way of life practiced by those great superfamilies of the Hymenoptera known as the parasitic wasps: the Ichneumonoidea, Proctotrupoidea and Cynipoidea, consisting of some thirty families. Although described as parasites they are not true parasites, in that eventually they kill the host. For them the term "parasitoid" has been adopted.

In the case of the parasitoids, the adult may not feed upon its victim. But the predatory wasps do not always consume their capture either. We have seen that they often carry it back to their young or even to the nest in which they will later lay their eggs. The adult parasitoid may lay its eggs near or on the body of its victim so that its emerging larvae may easily find the host upon which they are to feed. Or it may lay its eggs within the body of the victim by means of a sharp, needle-like ovipositor; the larvae, upon hatching, then feed internally, leaving the vital organs for their last banquet before pupation. The larva of the parasitoid, working at first as a parasite, carefully avoids killing its host; later it becomes a predator and destroys it.

Such selective behavior on the part of the Hymenoptera, whether predators or parasitoids, requires a rather high type of "know how." This slang expression is a lazy man's recourse when wishing to avoid a discussion of insect mentality. Certainly we can not credit the insect with intelligence, but the Hymenoptera unquestionably show a remarkable "adaptive behavior" in their selection of a host species, in paralyzing it without killing it, in either laying their eggs upon it, within it or near it or in carrying it to a previously prepared nest. The emerging young, unread and untutored, feeding upon the carefully preserved material, but sparing the vital organs, the destruction of which would kill the host, until last, are equipped with a pattern of behavior that seems intricate in design albeit simple in aim.

Ichneumoid wasp (*Heteropelma flavicorne*) parasitizing young caterpillars of Prominent Moth

The parasitoid wasps attack all stages of insects. Some species lay eggs only in the eggs of other insects. Many parasitize only the larvae. Others ignore the larvae and attack only pupae. But their ubiquity and their persistance account for a prodigious mortality among many species of garden pests. We have watched a female Ichneumonid attacking a brood of caterpillars of a Prominent Moth (*Schizura*) when the blistering defense secretion which the larvae emitted caused her to withdraw again and again to clean her face and antennae in seeming distress. And yet she continued until



Author photos

Parasitized egg of Spicebush Swallowtail

Ichneumoid parasite just emerged from Swallowtail Butterfly pupa

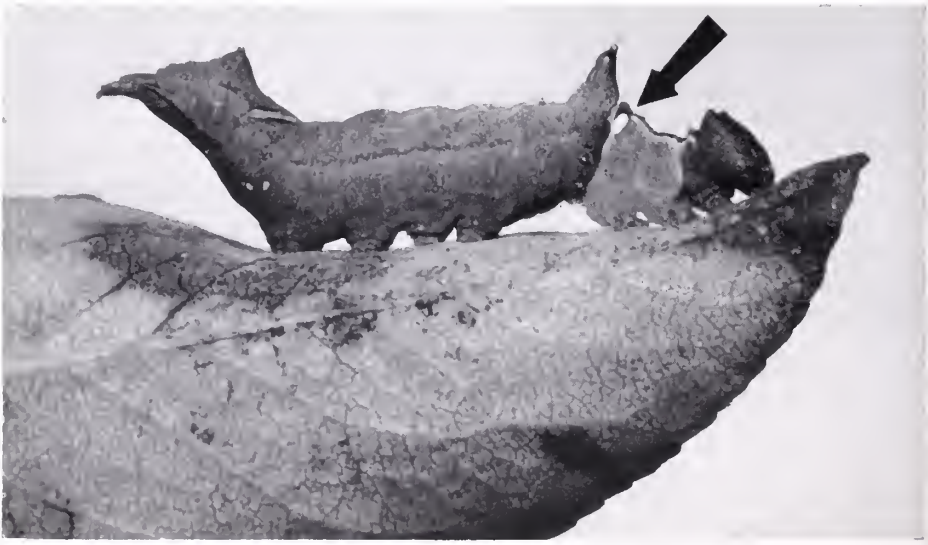
every one of the caterpillars had been parasitized by her needle-like ovipositor.

Counteracting, in some degree, the activity of these parasitoids are the species that parasitize the parasitoids. These secondary parasites may, in turn, be parasitized by tertiary parasites who thus swing the balance back in man's favor.

Thus the bees and wasps fulfill their beneficial destiny. Their relatives the ants, the third group of the Hymenoptera, also have an important role to play in the economy of the garden. They often assume the proportions of a major pest as they clamber over flower buds, injure tender fruit, destroy crops and ruin greenhouse seedlings; but the cost of their control is small compared to the tremendous, unseen benefits derived from their constant activity in loosening and aerating the soil, enriching it and making it pervious to water. Ants also kill large numbers of insects, a few of which may be beneficial but the vast majority of which are harmful, such as the great hordes of root destroying pests. The distaste we have for a few notoriously unpleasant species such as the fire ants, the Argentine ant and the various household-visiting species should not blind us to the benefits obtained from the group as a whole.

Larva of Prominent Moth with egg of parasite attached to thorax (arrow)

Author photos



A TRIBUTE TO THE PARASITE HUNTERS

Richard L. Doutt

MOST projects in biological control require the coordinated effort of several persons, and the sequence of events is very much like the functioning of a relay team where one man, having finished his assignment, passes the baton on to the next one who carries out his responsibility, and so on. In biological control it is the handling of the beneficial species that is passed along from one person to the next throughout the course of a project. First the parasite hunter must find the natural enemies of the pest in its native home; next these are shipped to a quarantine laboratory where they are carefully studied to determine their beneficial habits; then they are turned over to the insectary staff for mass breeding; and finally they are transported to the field for colonization, establishment, and subsequent evaluation. It is seldom that any one person can perform all of these tasks and therefore biological control is inherently a cooperative, teamwork effort. Each of these distinct phases in a project is very important, and each is largely dependent upon the success of the phase which has preceded it.

Qualifications of a Parasite Hunter

The person who undertakes the assignment of searching for natural enemies of a pest in its native home has an interesting, challenging, and yet an extremely difficult task. To be successful in this foreign exploration the entomologist must not only be very competent and experienced but he must exhibit extraordinary ingenuity, possess great patience, and have remarkable physical stamina. The late Dr. Filippo Silvestri, a parasite hunter of no mean rank, and one of Italy's famous scientists, gave a talk to the University of California Entomology Club at Berkeley, California on September 11, 1928, and to his audience of prospective parasite hunters he gave the following advice:

"1. Know the native home of the injurious pests for which natural enemies are desired. This is often very difficult and complicated.
2. Visit as many localities as possible in which the pest is native.
3. Collect as much material, including all stages of the beneficial insects desired in these different localities as is obtainable.
4. Collect the material over a long period of time, at least six or seven months or better a full year in order to secure as great a variety and quantity as is available.
5. From accurate observations and experiments, if possible, choose the most promising natural enemies available in the different localities.
6. Study the biology of the natural enemies and distinguish between primary and secondary parasites.
7. Eliminate all possibilities of introducing secondary parasites and other injurious insects.
8. Study methods of transporting the beneficial insects and provide sufficent food en route.
9. Introduce as many parasites and predators as possible.
10. Expect to contract and endure diseases and hardships often with poor accomodations.
11. Work all of the time to take care of the beneficial insects collected.
12. Surmont every difficulty.

13. Have confidence in and a real love for the work."

Many of the first nine points of Silvestri's advice have been modified by the advent of modern air transport, but the harsh realities of numbers 10, 11, and 12 are still with us. Therefore in these days of creature comforts with the forty-hour, five-day week being the rule rather than the exception it is perhaps surprising that anyone now undertakes the task of foreign collecting. However, there are persons who do this work today, and it is to them that economic entomology owes a real debt. This article is submitted as a minor tribute to these men and to acknowledge the personal sacrifice that they must make to carry on their work for the ultimate benefit of American agriculture.

Hardships of a Parasite Hunter

The difficulties encountered in foreign exploration and the characteristic perseverance of the men who do this work are well illustrated in the work of Dr. Frederick Muir, who searched for natural enemies of a sugar cane borer that was very damaging to the plantations in Hawaii at the turn of the century. Dr. Muir's published articles tell a few of the extraordinary hardships that a man encounters when he gives himself over to an enthusiastic study of science. Muir had traveled in search of the parasites of the cane borer, *Rhabdocnemis obscura* (Boisd.), through much of the East Indies and into the interior of Borneo without having much success. Therefore he moved his operations to Amboina, where after working in the miserable Sago swamps from April to August he managed to get sufficient material together for a shipment, but in spite of all the care he could give the insects they all died the day before he arrived with them in Hong Kong. Muir returned to the Moluccas to work out some more suitable way of handling the perishable parasites so that they could be transported successfully. He returned to Amboina in November, 1908, but had to wait a month for the mail boat to Ceram. He reached Ceram in the wet season and reported that "Never one day did I come home dry, on most days returning soaked from head to foot, and often spending hours in water up to my knees." With conditions so bad he decided to go to New Guinea.

"Upon arriving at Port Moresby the doctor told me I could land, but would have to go into quarantine, so I decided to do so. This proved quite a little Gilbertian episode which lasted five days. The quarantine house is a one-roomed iron place on the west side of the hill at the entrance of the harbor. I moved in with my boxes, a few cooking pans, and some tinned meats and biscuits, to live in splendid isolation for five days."

After leaving quarantine Muir moved to a camp in the Laloki district 15 miles from Port Moresby. To get there he had to cross the crocodile infested Laloki river on fallen trees. Such bridges were inconvenient to cross and "I sometimes preferred to cross on the seat of my trousers rather than on soles of my boots." Muir found a small parasitic fly at Laloki and he thought it best to remain there to collect it. His abode was a temporary one-roomed grass affair next to a swamp. The mosquitoes were terrible and at sunset he lighted a wood fire in the center of the room and turned into bed early.

Muir realized that "The difficulty is to get these small flies from such a distance, the shipping facilities being very poor, and great delay in trans-shipment being unavoidable. The best route is from Papua to Brisbane, and then by Vancouver boat to Honolulu, but the difficulty is to avoid delay along the Queensland coast."

"The method I decided upon was as follows: First, to get large colonies of borers established in healthy cane stems in the fields, then to expose them to the attacks of parasites under natural conditions, and then transfer root and stems to my cages and bring them back. By having a stock of unparasitized borers

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on hand I hoped to be able to get a second generation en route should the first hatch out before I reached Honolulu."

Muir prepared the material as planned but bad luck overtook him and before leaving Port Moresby he contracted typhoid fever, which compelled him to call in a doctor when he reached Brisbane. The doctor sent Muir to the hospital where he remained five weeks. A friend kindly put Muir's boxes on board the ship to Honolulu but with no one to attend to them during the voyage none arrived alive, although hundreds of the parasites had hatched out and died en route. So Muir returned to New Guinea to try once more.

With the education which came from these bitter experiences Muir decided to set up a breeding station at Mossman, Queensland and a Mr. Kershaw established this station while Muir was making his second collection of parasites in New Guinea. Finally arrangements were all completed and Muir managed to put a shipment together in April. He took it to Port Moresby on April 21, but the boat which was scheduled to leave on April 22 was six days late. In the meantime Muir became ill with fever and went to the hospital where his room was a part of a balcony divided off with corrugated iron with only two feet between his bed and the iron wall. Weak as he was, Muir went from the hospital aboard the ship which took him to Cooktown, Queensland. He missed the mail connection and thus had to wait in Cooktown 5 days although it was only 60 miles down the coast to his planned meeting with his helper, Kershaw. To add to his frustrations, the post office took 24 hours to get a telegram to Kershaw over this 60 miles. Finally, Muir got to Mossman on May 5 with 8 adult parasites still alive, and some puparia from which 83 adults later emerged. These were all put into the breeding cages which had been suitably prepared by Kershaw.

The following four weeks were a time of great suspense, because they were not sure that the flies would successfully breed. But they did rear through a generation of the parasites, and on June 29, Muir left Australia for Fiji taking 155 puparia with him. He planned to remain a month in Fiji to breed more flies, and he barely had time to stock a cage with the parasites when he again succumbed to malaria and went to the hospital in Fiji for two weeks.

Finally, on August 9, 1910 Muir left Fiji with his new generation of parasites and arrived in Honolulu on August 16 with a good colony of adult flies and puparia. The subsequent establishment of the New Guinea tachinid fly in Hawaii soon lessened the borer damage so that on most of the plantations the injury is no longer serious. As a result of the suppression of the borer there was an increase of about 0.7 tons of sugar per acre, and therefore the years of effort by Dr. Muir to introduce the parasite were amply justified.

It is necessary that a parasite collector be a keen observer of factors which cause mortality to insects in the field. Through such observations natural enemies are discovered which were previously not known to exist. Dr. Muir's discovery of the feeding habits of the now famous predaceous bug, *Cyrtorhinus mundulus* (Bredd.), is a case in point. This insect was known in Australia and Java, but because it belonged to a family of insects that characteristically feed on plants it was also thought to be plant-eating. In 1919 Muir was in Australia searching for parasites of the sugar cane leafhopper, *Perkinsiella saccharicida* Kirk., which was a very destructive pest in Hawaii. Muir noticed in Australia that a large percentage of the eggs of the leafhopper were dead and attacked by a fungus. In his account of this Muir wrote, "I found the fungus in the form of yeast-like spores present in old egg shells from which the young had hatched, which could be recognized by the egg cap being off, and also in unhatched eggs, which in itself was intriguing. In moist cells these spores gave rise to mycelia and then to fruiting bodies and yeast-like spores

Leptomastix dactylopii, a wasp which parasitizes mealybugs. Imported from Brazil to California by Harold Compere

similar to the original ones. Further investigation showed that these spores were present in all young and adult leafhoppers in the body cavity, where they multiplied by division; that they passed through the walls of the ovarian tubes and entered the young eggs, congregating in a small round ball at one end of the egg, and eventually becoming mostly incorporated into the embryo. As these were universal, it then became evident that the fungus could not be the cause of the dead eggs as otherwise all would be destroyed. Upon killing the egg by pricking, the spores developed. This led to observations in the field to discover what led to the death of the egg. The fact was then revealed that *Cyrtorhinus mundulus* pierced the egg and sucked it. In some cases the egg was sucked nearly dry, in others the egg was only pierced and very little sucked, but it led to the death of the egg and to the development of the fungus."

Muir therefore introduced the predaceous bug into Hawaiian sugar cane fields and complete control of the leafhopper resulted. This has been one of the most outstanding examples of biological control, and is due to the keen observations of Dr. Muir.

There have been many other parasite collectors beside Dr. Muir, and their travels and experiences are every bit as fascinating. George Compere began ten years of this work in 1899 and his travels in search of parasites of the fruit flies were so remarkable and extensive that a French entomologist, Paul Marchal, wrote of them as "L'ineroyable Odyssee de Monsieur Compere." There is now a second generation of parasite collectors. Harold Compere has made a permanent place for himself in entomology's hall of fame by doing the same type of work as did his father, George. The parasites which controlled the citrophilous mealybug in California and also the parasites which are most important in suppressing the black scale in the same state were discovered by Harold Compere in Australia and Africa, respectively.

The explorer's work may still not be finished even though he has collected the material, packaged the insects very carefully, and has taken them to the post office for shipment. A collector recently learned that his shipments were not arriving at their destination and found that the postal clerks were removing the valuable, uncanceled airmail stamps and

reselling them. They were tempted to do this because the amount of postage on the package was equivalent to about a month's wages for the postal clerk in that backward country.

The First Parasite Hunt

No account of parasite collectors would be complete without mentioning the first person who set about to obtain parasites in the native home of a pest. This man was Albert Koebele, an employee of the United States Department of Agriculture. In 1885 Koebele was working in Washington, D. C., and after what is said to have been an unfortunate love affair he asked to be transferred to some distant place. The most distant place then was California and so Koebele was sent there to work on insect problems, the most important of which was the control of the cottony cushion scale on *Citrus*. In 1888 it was decided that someone should be sent to look for parasites of this scale insect in Australia. There was a ban on travel outside of the United States by members of the Department of Agriculture, but this was circumvented in a very interesting way. There was a world's fair in Melbourne that year in which the United States was to have an exhibit, and a congressman from California was in charge. To aid his fruit growers in their effort to obtain parasites of their scale pest he arranged to have Koebele accompany his commission to the fair, ostensibly to represent the State Department but actually to collect insect parasites. Koebele succeeded in finding the now famous Vedalia beetle which not only controlled the scale in California but did it in such a dramatic and spectacularly successful way that biological control was firmly established as an important method of suppressing pests.

Koebele was skyrocketed to fame as a result of his Australian trip. The Germans with some nationalistic pride called biological control the Koebele method, since Koebele was born in Germany. The California fruit growers gave Koebele a testimonial banquet and presented him with a gold watch and Mrs. Koebele with a pair of diamond earrings. This event prompted Koebele's biographer to write, "I imagine that this presentation of diamond earrings to the wife of an entomologist as the result of his own work in entomology is probably unique. I happen to know of no other entomologist who has been able to see that his wife wears diamond earrings."

Biological control is now 72 years old, and the Vedalia has maintained its complete control of the cottony cushion scale in California for all of this period. This demonstrates the permanence of the method when an effective parasite becomes established. The hunt for parasites continues today and the search has been broadened to include enemies of weeds. The introduction of weed-feeding insects has resulted in impressive control of certain weed species in California, Hawaii and Australia. The value of biological control is thus very evident and it has gained world wide recognition and support, but the surface has barely been scratched and the parasite hunters will be needed for many more years.

Cryptolaemus montrouzieri, a lady beetle which feeds upon mealybugs. This beneficial beetle was imported from Australia by Albert Koebele in 1892

Photos John Black

A WOMAN PARASITE HUNTER

Irene D. Dobroscky

"GO WEST, young man," said Horace Greeley. After working at the Boyce Thompson Institute for Plant Research for six years I felt that this advice applied to me, also. At the Institute my title was assistant entomologist and plant pathologist, as my work was with plant virus diseases and their insect vectors. While at Cornell I had specialized in both these fields and my Master's thesis was on insect parasites of birds. During the time I was at the Institute, I worked on the morphology of the insect which carried the virus of aster yellows and this was the topic of my Doctorate thesis at Cornell. Later my special problem was to find the cause of a disease called "False-blossom" of the cranberry. This work was carried on partly on the cranberry bogs of New Jersey where I collected insects and partly at the greenhouses of the Institute where I raised healthy cranberry seedlings for the experiments. Within two years I was able to prove without a doubt that this was a virus disease and was also able to pinpoint the insect vector. It has been a source of satisfaction to me to reflect that as an individual I was able to solve for the cranberry growers one of their most serious problems, whereas the government is reported to be now spending twenty million dollars to compensate these growers for a government-imposed debacle.

In 1930, I decided to "Go West," and a friend from the Institute went along in my "Dauntless Dodge." Before we reached Los Angeles, we knew what it was to be stuck in snow drifts at the top of the Rockies at Berthould Pass; to see the Dodge literally carried through the mud by a willing coterie of cow boys; to jounce over miles of corduroy road, and to ride endlessly, squinting into the western sun over unpaved desert roads.

In a half-hearted way, I had been looking for a job. In Tucson, Arizona, there was an opening in field extension work but they just couldn't give it to a *woman*. This was a wall I came up against several times, even though they admitted that my qualifications were excellent.

However, my heart was set on getting to Hawaii. Two of my colleagues at the Institute, Dr. Helen Purdy and Dr. L. O Kunkel, who had both worked for the Hawaiian Sugar Planters Association, had filled me with such glowing tales of the beauties of Hawaii that nothing short of getting there would satisfy me. Besides, as an entomologist I was well acquainted with the remarkable work which had been done with parasitic insects on this island. So the Dauntless Dodge and I took sail from San Francisco for Honolulu. Luck was with me, for on shipboard was Mr. D. T. Fullaway, the Government Entomologist of Hawaii. With nothing to do for five days but talk, we soon became well acquainted and it was through his knowledge of my qualifications that I was offered a job a couple of months after landing. Hawaii lived up to all my expectations. The land and the people were surpassingly fair and even the scientists were mellow and human.

One of the scientists of the Experiment Station of the Hawaiian Pineapple Canners' Association had discovered that the yellow-spot disease of pineapple was a virus disease and a thrips was the vector. Here was a problem quite similar to the false-blossom of cranberry. But in New Jersey the growers controlled the offending insects with insecticides, in Hawaii they decided to try control with a parasitic insect. It was known from literature that the bean thrips of California was parasitized by a very small Chalcid, a member of the wasp order. There was also a record of thrips being parasitized in Java. With this information as a start, it was my assignment to hunt for such a

parasite in the Philippines and failing there, to go to Java. I had just one week in which to read the literature on the subject, plan how to carry out the work, get together the necessary equipment and finally to climb on board the beautiful Empress of Japan with the trusty Dodge. It took nineteen days to get from Honolulu to Manila. Those were the days before Amelia Earhart.

If I thought the Hawaiian Islands a paradise, I found Manila in May just the opposite. Here one had to get up early and get in a full day's work by one o'eloek, then hurry home to eat and take an obligatory siesta under a mosquito bar in a darkened room until the sun began to set. At this time, everyone was glad to go out to see the magnificent speetacle of the sun setting over Manila Bay in the most fantastie riot of clouds and colors to be seen anywhere in the world.

Armed with letters of introduction, I was welcomed at the Bureau of Scienee and given an office. Dr. Fajardo, who had studied plant pathology in the United States, was assigned to help me start looking for parasites. Several times we visited the nearby Chinese truek-erop gardens where night soil was being used. In spite of elose observation I was not able to find any inseets on these crops. As for the Chinese farmers, they were much amused to see a white woman in their midst and their Chinese eomments were no doubt untranslatable.

Beeause these gardens were not produetive of inseets, I deeided to go to the Agricultural College at Los Banos, 44 miles south of Manila, a plaee that about ten years later was the site of a Japanese eoncentration camp. Around the College, various test erops were planted, ineluding soy beans. They were in bloom and elose examination showed they harbored thrips. A paper bag full of infested flowers was eollected and taken baek to the laboratory in Manila. Tearing apart the flowers and eollecting the thrips I notieed three minute wasp-like inseets. Putting one of these ereatures in a small vial with a few larval thrips, I soon diseovered that the little wasp climbed on the back of the larva and tried to pierce the abdomen with its egg-laying ovipositor. After watching and seeing the process repeated a couple of times, I was sure that this was IT. Golden nuggets never looked better to a prospector than this minute insect did to me. It was so small that several of them could dance on the head of a pin. Yet it is by means of such tiny things that scientific progress is made. Not being able to contain myself for joy, I rushed down the hall to show my treasure to the scientists from the Rockefeller Foundation who were working on bird malaria. This was my great moment. It was just about a month sinee I had landed and I had already found my parasite. But, of eourse, this was only a good beginning; I still had to rear it and bring it baek alive to Hawaii.

I deeided to move to Los Banos, home of the parasite. Here I had an old laboratory building all to myself. It had been built by the Hawaiian Sugar Planters' Assoeiation and previous seientists had made history here. They as well as I were no doubt pestered by bat bugs which dropped down from the ceiling. I, at least, did not find a eobra as my predeeessors had. With the help of a native boy, Emilio, I worked here for several months. Emilio, whose wages were fifty cents a day, would go off with my eollecting net and swoosh around with it, eollecting all sorts of insects. He would also piek a bag of bean flowers and bring them to me in the laboratory.

In the eourse of time I was able to work out the eomplete life eyele of the bean thrips and its parasite. It took the thrips about three weeks to complete its eyele but the parasite lived inside its host only about eleven days. These figures were significant, for the parasites had to reach Honolulu alive after an ocean trip of nineteen days. Several unsueeessful attempts were made to send vials of parasitized thrips. Whenever a ship was leaving for Honolulu, I'd package up some of the insects, drive to Manila, then walk

(*Please turn to page* 94)

CONTROL OF INSECTS BY PARASITES AND PREDATORS

Neely Turner

BIOLOGICAL control of insect pests has been an intriguing subject since the first discovery that insects had parasites. It was recognized then as now that only a small proportion of the species of insects appear in large numbers. It was believed then as now that biological control was responsible for the relatively small numbers of most species. Obviously if this is true, the abundant species could also be reduced to small numbers if the same sort of biological control could be invoked.

This idea has been emphasized from the earliest days of economic entomology. Kirby (Rector of Barham) and Spence said in 1822, "An all-wise Providence has proportioned the number of each group and species to the work assigned to them." But a few pages later they say, "When any species multiplies on us, so as to become noxious, we certainly have a just right to destroy it, and what means can be more proper than those which Providence itself has furnished?"

From that time until the successful use of the first insecticide ways were sought to encourage or perfect biological control. There was also a more or less constant search for the sort of parasites that keep insects scarce. When imported pests became destructive, it was reasoned that the pests had come in without their parasites, so there was a concerted effort to find and bring in parasites and predators.

The introduction of the ladybird beetle (*Rodolia cardinalis*) from Australia to control cottony-cushion scale in California in 1889 was such an outstanding success that it stimulated importation of other parasites and predators for other imported pests. Dozens of species attacking many pests were brought in, and many were established. Others found the climate or the absence of alternate hosts unfavorable and failed to survive. The spectacular success of *Rodolia* has not been repeated.

Similarly, the reasons why some insects remain scarce are still elusive. We know that biological control is seldom effective enough to destroy a species of insect. We also know that insects seldom multiply at more than a small fraction of their potential rate. Kirby put it this way ". . . the operations of insects (are) so directed and overruled as to effect the purposes for which they were created and never exceed their commission: nothing can furnish stronger proof than this, that an unseen hand holds the reins, now permitting one to prevail and now another, as shall best promote certain wise ends; and saying to each, hitherto shall thou come and no further." Modern ecology has introduced "density-dependent factors" as the hands holding the reins, but they are still unseen.

Interest in biological control has fluctuated almost as greatly as the number of pest insects. The introduction of Paris green about 1869 stopped interest in parasites of the Colorado potato beetle. Arsenate of lead was so effective in controlling codling moth that biological control was forgotten until the worms developed resistance to the poison. The peach growers of Connecticut contributed to a fund for raising parasites of the oriental fruit moth until DDT was introduced. And in 1960 biological control is again

"fashionable" because of (1) development of resistance to insecticides, (2) problem of residues on crops, and (3) anxiety that insecticides may also prove destructive to wildlife.

Biological Control Not a Complete Solution

Whatever practical use biological control may have, it is not something to which we can turn only when nothing else works. Sweetman has said in his book on the subject, "It would therefore be extremely unwise, especially when we have to deal with a major pest of a large area, to rely exclusively upon the method of biological control for the solution to our problems."

A careful study of some of the research on biological control will show some of the reasons for such a statement. Dr. R. L. Beard of The Connecticut Agricultural Experiment Station has studied an internal parasite of the squash bug. This parasite is probably the limiting factor in regulating the abundance of squash bugs. But it kills the bugs *after* they have fed on the plants and caused maximum damage. Thus it is a very effective parasite, but not a good preventive of squash bug damage.

The eastern tent-caterpillar is native and has a large number of parasites. It has been shown that tent-caterpillars increase more rapidly than their parasites for a while, and then the parasites "catch up," and the tent caterpillars seem to disappear. Then most of the parasites perish, and the "cycle" starts again. Thus, the parasites may be very effective over a ten-year period, but not prevent severe outbreaks one or two years out of ten.

Biological Plus Chemical Control

This has led to proposals for a combination of insecticides and biological control. Thus, Pickett and his associates in Canada have tried to select fruit spray materials that affect parasites the least, and use them as little as possible. Entomologists at the University of California have called this integration of biological and chemical control. It offers much promise in controlling serious pests by making use of both means of control.

All this is not very comforting to the gardener faced with infestations of insects on choice plants and anxious to avoid the trouble of spraying. The magic formula for biological control has not been found, but there are some applicable suggestions.

1. The greater the variety of plants and habitats in an area, the larger the probabilities of biological control.

2. The predators which feed on a variety of insects are generally more effective in controlling pest insects than the internal parasites, which are usually specific in their hosts. The spiders, lady beetles, ground beetles, predaceous bugs, lacewings and some ants are general predators.

3. A couple of years of observation will establish the types of plants that can be grown in a garden without serious pests. For those who won't want to spray, the varieties damaged regularly can be eliminated.

4. Hand-picking of insect pests, the oldest "applied biological control," is a practical method for many insect pests.

5. Insects are animals that may happen to be in a garden, and not arch enemies deliberately destroying beautiful plants.

6. If the general effect is considered, a moderate amount of damage does not ruin a garden, even if it does spoil perfect individual specimens.

7. If insecticides are to be used, they may be applied only when necessary and only to infested plants. Most insecticides are so potent that very small amounts are required. *Excessive use does not control pests any better than proper use, but does tend to kill more parasites and predators.*

8. Knowledge of the identity of both pest and beneficial insects is essential. Pest insects are described and illustrated in a number of garden manuals. There seems to be no single popular account of parasites and predators.

GALLERY OF INSECT FRIENDS

Some helps for recognizing them

Cynthia Westcott

A COMMON question in recent months is, "How do we recognize beneficial insects; how do we distinguish between friend and foe?" It is not always easy. Frequently in my plant doctoring days I have had a client get excited about a horrible pest on her rose that turned out to be the larval stage of a green lacewing or some other friend. Nearly all of the orders of insects commonly found in gardens have members that are "good" and a few that are "bad" from a gardener's standpoint. Let's run briefly through these orders and see what the score is.

Connecticut Experiment Station

Chinese mantid (*Tenodera sinensis*) in typical head-down position

Orthoptera

Here are the destructive **grasshoppers** and **locusts** but here also are the **mantids** (see page 43). If, when I start to spray a rose in late summer, I see a praying mantis I move her out of spray range. And if, when pruning in spring, I inadvertently cut off an egg case, I stick it on some other plant.

Dermaptera

Earwigs are pretty much of a nuisance in the house and they do feed on some flowers and foliage but they also act as scavengers and occasionally feed on other insects.

Thysanoptera

Thrips are very minute slender insects with fringed wings. Gardeners with roses that ball up and turn brown and with streaked and speckled gladiolus will be surprised to know that there are some useful members of this group. The banded thrips (*Aeolothrips fasciatus*), yellow to dark brown with three white bands, is common on clover, chrysanthemum, dahlia and other flowers, feeding on other thrips, aphids and mites. The six-spotted thrips (*Scolothrips sexmaculatus*), with narrow wings, feeds on mite eggs and nymphs. The black hunter (*Leptothrips mali*), very dark with white wings, feasts on eggs and young of various scale insects.

Hemiptera

These are the **true bugs**, with "half-wings," part hard, part membranous,

Ambush bug (*Phymata erosa*) on goldenrod

folded flat over the back. This order includes some very mean pests but also many friends. Among the latter are the **flower bugs** (family Anthocoridae). These are small, 3 to 5 mm., mostly black with white markings, usually found on flowers feeding on small insects and their eggs. One species (*Orius insidious*) works hard sucking on mites, thrips, and young scale insects.

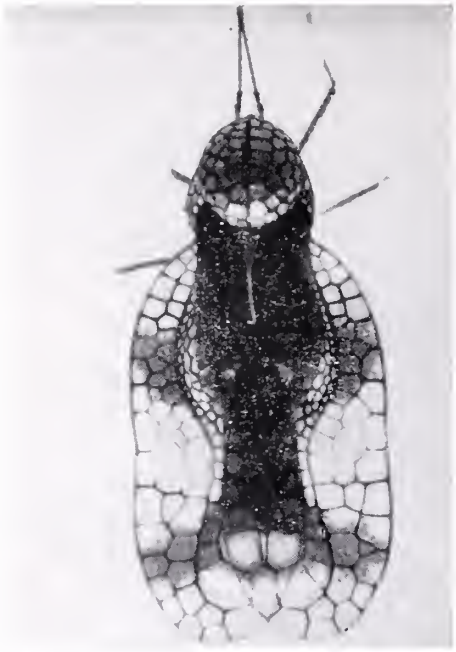
Leaf bugs (Miridae) are mostly harmful with a few predaceous species. Ambush bugs (Phymatidae) are ½ inch or less long, stout, with odd shapes and front legs adapted to grasping much larger bees and wasps. They lie in wait on flowers, often on goldenrod which matches their yellow-green color. Some species, as *Phymata erosa* that likes honeybees, might be considered more injurious than beneficial.

Assassin bugs (family Reduviidae) are medium to large, usually black or brown, with a wide abdomen. Some, known as "kissing bugs" may attack man, some may feed on honeybees, but many are useful in killing leafhoppers and caterpillars.

Assassin bug (*Sinea* sp.)

Photos A. B. Klots

Assassin bug (*Zelus exanguis*)



Lace bug, a pest which is not to be confused with the beneficial lacewing (next page)

Damsel bugs (Nabidae) are wholly predaceous. They are small, black or brown, soft, with body narrowed toward the head, long beak, and front legs modified for grasping small insects. The common damsel bug (*Nabis ferus*) eats aphids, leafhoppers, treehoppers, and small caterpillars.

Lace bugs (Tingidae) are exclusively plant feeders and so all are injurious. So are most of the **chinch bugs** (Lygaeidae) but one species (*Geocoris punctipes*) feeds on small grass insects.

The **leaf-footed bugs** (Coreidae) include the destructive squash bug but also some predaceous species. Stink bugs (Pentatomidae) include **soldier bugs** (*Podisus* spp.) that like cankerworms and other smooth caterpillars and cutworms. Unfortunately they may also eat lady beetles and lacewings.

Homoptera

From our standpoint, this order is composed entirely of pests—scales, aphids, leafhoppers, spittlebugs, planthoppers, whiteflies, and psyllids.

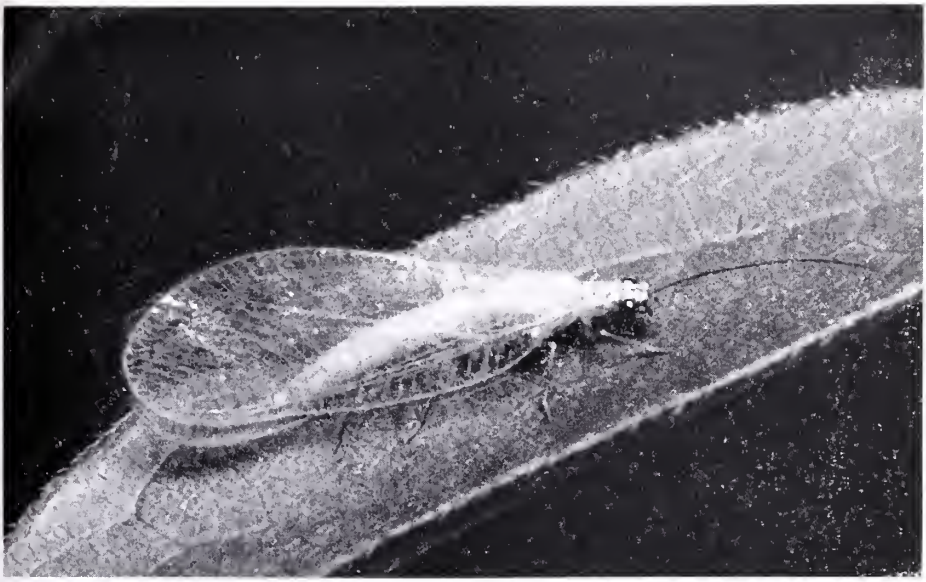
Neuroptera

The "nerve-winged" insects of this order have similar membranous front and hind wings that are held in a roof-like position. The rather ugly larvae have double sickle-shaped jaws. The larva of *Chrysopa occulata* (family Chrysopidae) is known as an **aphid-lion.** It has a flat body tapering at both ends, yellow or gray mottled with red or brown, with projecting hairs or bristles, ¼ to ⅓ inch long, with a habit of carrying trash over its back (see page 59). It captures, punctures, and sucks the juice from aphids, mealybugs, cottony-cushion scales, sometimes thrips and mites. The adult is the beautiful golden-eyed **lacewing** with gauzy green wings, long hairlike antennae, iridescent red-gold eyes. She lays her oval white eggs singly at the end of hairlike stalks so that her cannibalistic offspring do not eat each other as they hatch. The larva pupates in a globular white cocoon, often on the underside of a leaf, and the adult cuts out a small lid which swings back as on a hinge as she emerges. Laeewings are common in our gardens.

Larvae of the **brown lacewings** (Hemerobiidae) are known as aphid-wolves. Some are common in the West and are

Photos Connecticut Experiment Station

Stink bug (*Podisus placidus*) feeding on currant worm



A. B. Klots

Adult of golden-eyed lacewing

A. B. Klots

Chrysopid larva encased in skins of victims attacking an aphid

Stalked eggs of lacewing

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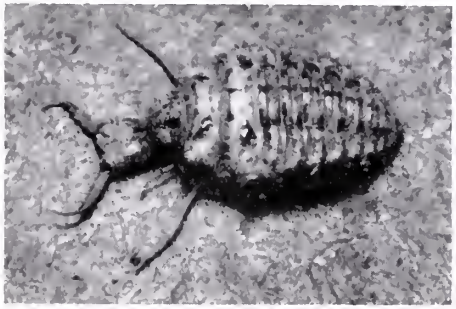
Adult of ant-lion somewhat resembles dragon-fly

very helpful against mealybugs, aphids, chermids and whiteflies. (See figure on page 21).

Ant-lions (Myrmeleontidae) are similar to damsel flies as adults, soft-bodied, with narrow, many-veined wings and a long slender abdomen. The larvae are known in the South as doodle-bugs. They dig pits, an inch or more across, in sandy soil and lie in wait at the bottom for ants and other victims to fall in.

Coleoptera

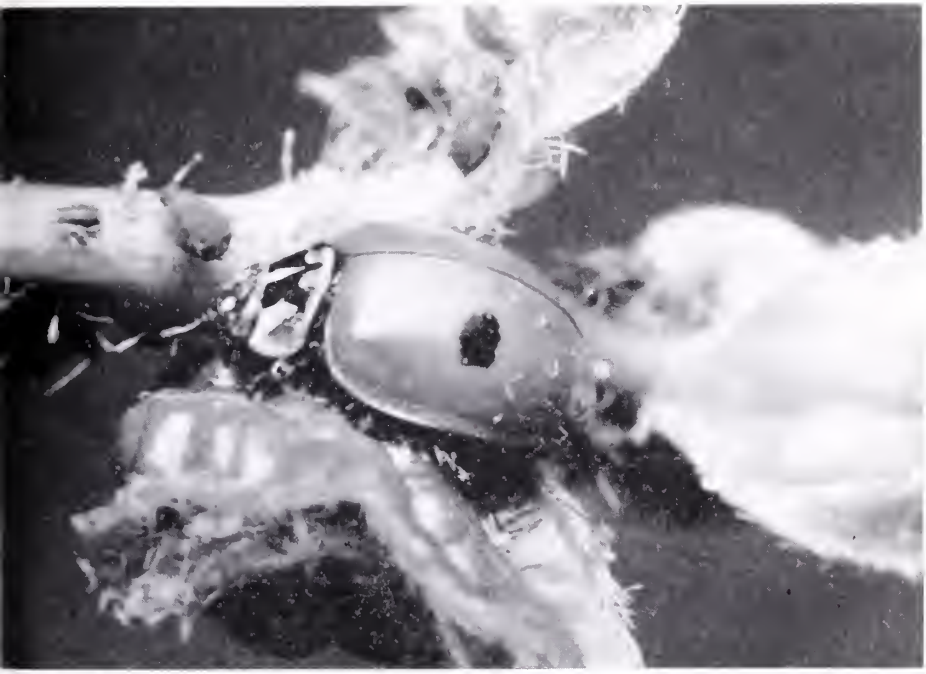
The beetle order includes some of our worst enemies, like Japanese beetles, and some of our best friends. Preeminent among the friends are the **lady beetles** (Coccinellidae) with the Mexican bean beetle an injurious exception. Lady beetles have been discussed at length in Dr. Hagen's article (pp. 28-35). I hope he has convinced you that it will not help



Larva of ant-lion

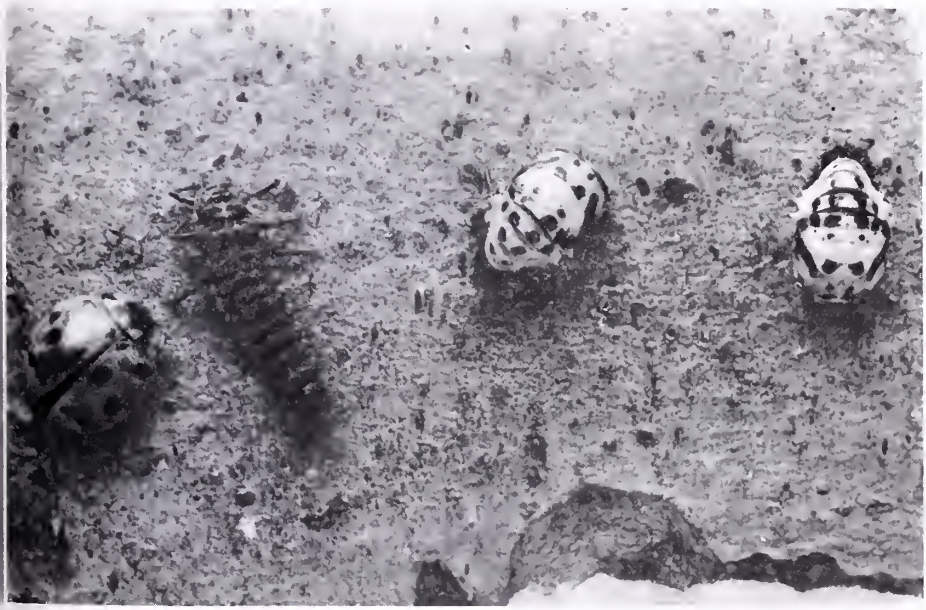
Photos A. B. Klots

Ant-lion larva digs conical pits in sand to trap insects



A. B. Klots

Two-spotted lady beetle eating aphids



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Adult, larva, and pupae of fifteen-spotted lady beetle

Tiger beetle (*Cicindela sexguttata*)

Ground beetle (*Carabus sylvosus*)

Photos A. B. Klots

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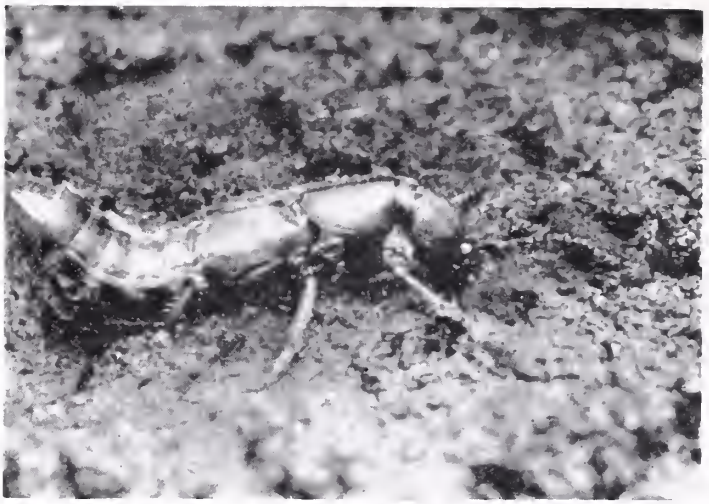
Ground beetle (*Calosoma scrutator*)

your own garden much to import Hippodamia from California for she will only fly away. Better put your faith in some of our common eastern species. The two-spotted lady beetle (*Adalia bipunctata*) is always around to help unless we spray too much. I always depend on this lady to tell me when aphids are hatching on roses for she finds them long before they are big enough for me to see. And then I try to use a selective spray, rotenone or pyrethrum or nicotine, that will kill the aphids and not be too hard on the beetles. Not everyone recognizes the flat larvae, tapering to the rear, dark gray with blue or orange spots, but they are awfully nice to have around.

Tiger beetles (Cicindelidae) are beautifully colored adults and ugly larvae waiting in burrows for prey. Cicindella is iridescent blue, green and bronze, ¾ inch long. The white, yellow or dusky larvae feed on small insects.

Ground beetles (Carabidae) are large, shiny, with shield-shaped bodies and prominent jaws. Some are black, hiding in your garden soil during the day, coming out to feed at night. Learn to know the difference between ground beetles and June beetles which are also dark, also large and found in soil, but with more rounded wing-covers. Do not step on the former; crush the latter. The European ground beetle (*Calosoma sycophanta*) imported to aid in the control of gypsy and brown-tail moths, is a brilliant iridescent blue and green with a golden sheen. In New Jersey where we do not have gypsy moths this species climbs trees in search of cankerworms.

Rove beetles (Staphylinidae), slender, with very short fore-wings, often raise



Rove beetle
(*Staphylinidae*)

the tip of the abdomen when running. The red spider destroyer (*Somatium oviformis*) is very small, black, and hairy. It lays orange eggs on leaf surfaces and the yellow larvae consume about twenty aphids per day.

Checkered beetles (Cleridae), important enemies of many wood-boring beetles, are long, almost cylindrical, brightly marked, and covered with dense hairs.

Fireflies or **lightning bugs** (Lampyridae) are long, soft-bodied beetles with luminous segments near the end of the abdomen. They feed on slugs and snails.

Soldier beetles (Cantharidae) are similar but without the light-producing organs. The larvae are predaceous, the adults are commonly found on flowers. A common species, *Chauliognathus pennsylvanicus*, has yellow wings with a black spot.

Blister beetles (Meloidae) are definitely harmful as adults but their queer, strong-jawed larvae eat grasshopper eggs.

Tumbling flower beetles (Mordelidae) are tiny, wedge-shaped, humpbacked, carry their heads bent down, and are

Photos A. B. Klots

Soldier beetle
(*Chauliognathus pennsylvanicus*)

black covered with light hairs. They are common in light-colored flowers and although not definitely classed as predaceous when I find them associated with thrips on roses I surely hope they are getting a meal.

Members of most of the other beetle groups, the scarabs, the leaf-eaters, bark beetles, wood borers, weevils and curculios, have to be classed as pests.

Lepidoptera

Many of our beautiful moths and butterflies have caterpillar larvae that feed on plants and so are considered injurious.

Diptera

Most insects have two pairs of wings as adults but the flies are distinguished by having but one pair. Larvae are legless and known as maggots.

Robber flies (Asilidae) have the top of the head hollowed out between the eyes; some species look like bumble bees. The adults are highly predaceous, attacking wasps, bees, dragonflies, grasshoppers and sometimes man. The larvae live in the soil and feed on other larvae.

Syrphid or **flower flies** (Syrphidae) are mostly bright colored and look like bees; the larvae are of various shapes. Most are predaceous on aphids and scale insects but the large yellow maggot of the narcissus bulb fly is distinctly harmful, hollowing out the bulb.

Robber fly (*Asilidas*)

Adult syrphid fly (*Spilomyia fusca*)

Syrphid fly larva eating aphids

Photos A. B. Klots

Syrphid fly larvae eating woolly aphids

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Tachinid fly (*Trichopoda fusca*)

Enlarged head of Tachinid fly (*Archyta apicifera*)

A. B. Klot

Parasitic larva of Tachinid fly that ha just emerged from a Noctuid caterpillar o which little remains but the skin

A. B. Klot

Tachinid flies (Tachinidae) resemble house flies and they are all beneficial parasites on other insects, glueing their eggs to the skin of the host or to leaves which will be eaten by it. One species parasitizes a hundred kinds of caterpillars; others work on cutworms and armyworms.

Hymenoptera

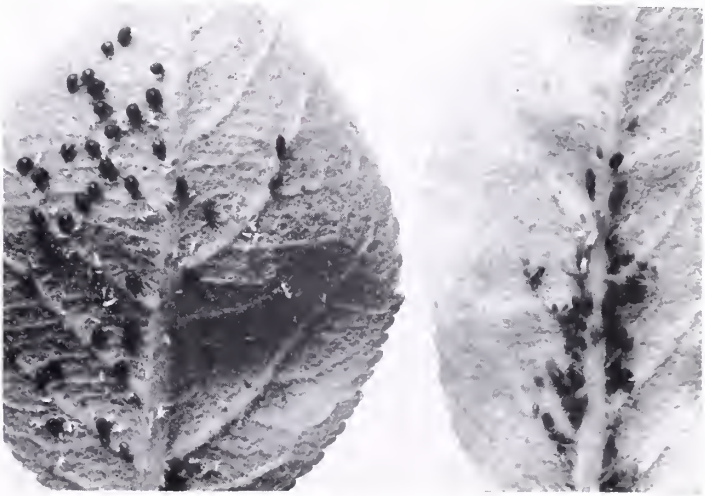
Sawflies, wasps, bees and ants have two pairs of transparent wings that are hooked together. **Ichneumon wasps** (Ichneumonidae) are slender with a very long ovipositor (see page 45). This can even penetrate tree bark to deposit eggs in wood-boring caterpillars.

Braconid wasps (Braconidae), small and stout, are important parasites of aphids. Note the many dead aphids in your garden with a round hole in the back. Braconids also kill many caterpillars, sometimes pupating in cocoons outside the body. Those white oval objects so often seen on tomato hornworms are not eggs but cocoons of this wasp.

Braconid wasp (*Microbracon hebetor*) on Wax Moth larva

Tomato hornworm parasitized by Braconid wasp

Connecticut Experiment Station Photos



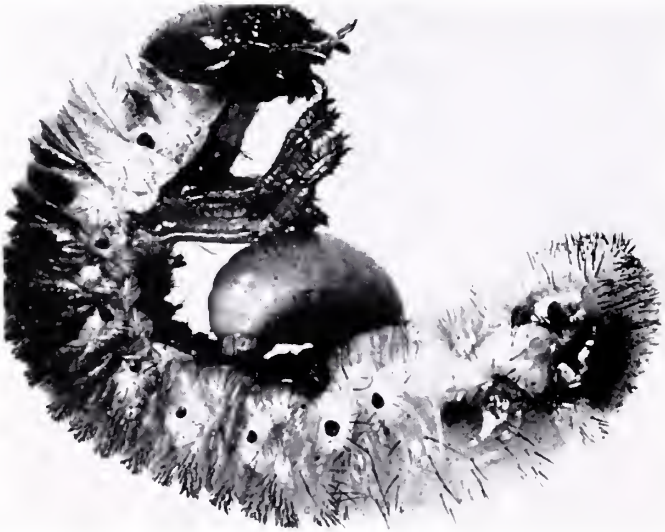
Apple aphids parasitized by Braconid wasps on left; healthy aphids, right

Chalcid wasps are very small and short-bodied. They are parasites on larvae of beetles, moths or butterflies or hyperparasites, living on other parasites. Members of the family Trichogrammatidinae are very small egg parasites. Some have been released in large numbers to control orchard pests. See the article on Beneficial Hymenoptera (page 44) for discussion of some of the predator wasps.

Members of the family Tiphiidae are parasitic on larvae of scarabaeid beetles.

U.S.D.A.

Tiphia wasp adult



Tiphia wasp larva feeding on Japanese grub

U.S.D.A.

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Japanese beetle grub infected with milky disease

One species (*Tiphia popilliavora*) was introduced into this country to aid in the control of the Japanese beetle. The adult is black, medium-sized, and somewhat hairy. Beneficial as this species is, it has probably been less effective in reducing the Japanese beetle population than the distribution of a commercially prepared powder, containing spores of bacteria that cause beetle grubs to succumb to a "milky" disease. The next article, by Dr. McEwen, takes up biological control by means of the dissemination of disease organisms rather than by insect parasites and predators.

MICROBIAL INSECTICIDES FOR INSECT CONTROL

Disease-causing microbes are proving to be an effective weapon against many insects

Freeman L. McEwen

New York Experiment Station

WHILE it is true that insects, on the one hand, are a necessary and often a colorful part of our surroundings, those who wish to grow ornamental or edible plants must be constantly on the alert to prevent an unacceptable amount of loss or damage from the pestiferous forms. For many years, entomologists have studied insects in an attempt to devise controls for those which destroy our plants without eliminating the many beneficial members of the insect world. In general, we have not been able to attain this goal completely. We have thus been forced to use chemical insecticides extensively and most of these do not distinguish between the good and bad insects.

From a practical standpoint, the chemical insecticides have provided excellent insect control to both the home gardener and the commercial grower. Among the insecticides on your dealer's shelf can be found materials which will "solve" practically any insect control problem. Use of these effective insecticides, however, has often created some serious side effects. One of the more serious is the destruction of various beneficial insects that feed on the pest species (below). Where this occurs, we lose the effectiveness of one of nature's methods of keeping insect populations at a reasonable level with the result that heavy outbreaks of pest insects may develop.

Predaceous and parasitic insects are only one of the forces in nature which keep various insects in balance. Perhaps equally important in many cases are the disease organisms which often appear to wipe out entire insect populations in the field.

In recent years, many entomologists have studied these insect diseases with

Full grown larvae of a small wasp, *Apanteles glomeratus* L., emerging from the body of an imported cabbageworm which they have killed

renewed vigor. It has been shown that some of these can be utilized to man's advantage in his war against various insects. In brief, the production of "microbial insecticides" is now a reality.

What Is a Microbial Insecticide?

Diseases of insects are caused by the same types of organisms that cause disease in other animals and in plants. They may be fungi, bacteria, viruses or other microscopic organisms but, as far as is known, none of the organisms which cause diseases in insects are harmful to other forms of life. Upon learning this, many entomologists set about to study the production of organisms which cause insect disease and to prepare these microbial insecticides in such a way that they could be applied in the field as you would a chemical insecticide.

Idea Not New

The concept of utilizing insect disease organisms to control insects is not new. Preparations of these were employed in Europe almost 100 years ago. The use of a fungus disease to control the chinch bug in the Central States was widely advocated around the turn of the century and, in this connection, some 50,000 packages of the disease organisms were distributed. These early attempts were not too successful. Just why this was so is not known but we do know that the types of organisms they were using, the fungi, are greatly affected by weather conditions and many are effective only during moist periods when the humidity is quite high.

Work in recent years has been concerned more with bacterial and viral insect pathogens (disease producers) and, in these areas, considerable progress has been made. Today, as many of you know, you can purchase a preparation of *Bacillus popilliae* Dutky (causing "milky" disease) for Japanese beetle control. Preparations of *Bacillus thuringiensis* Berliner, a bacillus toxic to several of our more common lepidopterous larvae (of moths and butterflies) are also now available.

Three Groups

When we try to devise a control program which will protect our plants from a particular insect species, our choice of insecticide is governed, in part, by the habits of the insect involved. For example, an insect that feeds directly on maturing fruit must be killed quickly and also with an insecticide which will not leave a poisonous residue. One which feeds on forest trees or on the foliage of potatoes may not affect the crop value directly and, hence, less rapid control may be satisfactory. In this case, a different type of insecticide may be used. In considering microbial insecticides, insect feeding habits are especially important. Here we must bear in mind that with many of these a disease is involved and, as is the case with diseases of other animals or plants, a considerable period of time may elapse between the initial acquisition of the disease and the development of sufficient illness in the insect to prevent it from feeding. For practical purposes, we can probably think in terms of three types of insect-microbial insecticide relationships.

The first type includes those organisms which destroy the insects quickly. This rapid action may be due to a rapid development of the disease organism in the insect tissues. This is the case with some diseases caused by nematodes or protozoa. In other instances, rapid kill may be due to some poisonous substance which the disease organism produces. This is the case with *B. thuringiensis* Berliner for many of the insects subject to control by preparations of this organism. And, while we call this microbial control, what is involved here is essentially a *chemical* control, employing a chemical of microbial origin. In some other insects, however, this bacillus produces a disease, and where this occurs, death is not nearly so rapid.

In a second category, we can include a group of insect diseases which bring on death over a relatively longer period of time (4 to 10 days) but where the amount of damage done by the pest in-

sect during this period can be tolerated. As examples, we might consider virus diseases of some of our pests of forest, forage and cole (cabbage, kale, etc.) crops.

The third category includes those diseases which develop slowly so that crop protection is not achieved the year the disease organism is applied. In such cases, the application of a disease organism may have little value in protecting fruit, etc., from damage during the current year. It may, however, have great indirect value in that by ultimately killing a high percentage of the pest species few will survive the winter to produce a serious infestation the following year.

Perhaps a closer look at representatives in each of these categories will help us to understand better where each may serve in insect control.

Group 1, Immediate Control

It is almost fifty years since diseased meal moths were sent from a flour mill in Thuringia to a specialist in Germany who reported that the disease was caused by a bacillus which he named *Bacillus thuringiensis*. Although this organism has been identified as the cause of insect diseases a number of times since then, it is only in recent years that its serious use in control has been investigated. These investigations have shown that in addition to the disease caused by the bacillus in a number of insect species, a toxin is produced. This toxic substance is an oval- to diamond-shaped crystal which appears in the bacterial cells when the bacillus matures (above). Many species of lepidopterous larvae are susceptible to the bacillus toxin although with some the susceptibility is of such low magnitude that economic control is questionable (see table). In addition, the fact that an insect is susceptible does not mean that the bacillus or its toxin will provide field control. To be effective, *Bacillus thuringiensis* must be taken into the insect with its food. Thus, where an insect feeds predominantly within plant tissue as do the codling moth, European corn borer and corn earworm, it is difficult to place the material in a site where a sufficient amount will be consumed by the insect to cause death.

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Microscopic view of mature and near mature cells of *Bacillus thuringiensis* Berliner showing toxic crystals (arrows) produced along with spore in each sporangium

Field tests have shown that at low dosages this bacillus provides excellent control of the imported cabbageworm, alfalfa caterpillar and tobacco hornworm (page 72). An increased dosage will provide field control of such pests as the

Some agricultural pest lepidopterous larvae susceptible to *Bacillus thuringiensis*

Insect	Outlook for commercial control
Diamond-back moth	Excellent
Imported cabbageworm	"
Alfalfa caterpillar	"
Celery leaf tier	Good
Tobacco hornworm	"
Tomato hornworm	"
Cabbage looper	Fair
Red-banded leaf roller	"
Zebra caterpillar	"
European corn borer	Questionable
Cutworms	"
Armyworms	"
Corn earworm	Poor
Codling moth	"

Courtesy R. L. Rabb

Tobacco hornworm killed by *Bacillus thuringiensis* Berliner

Collecting virus-infected larvae of cabbage looper for use as insecticide in field tests

New York Experiment Station

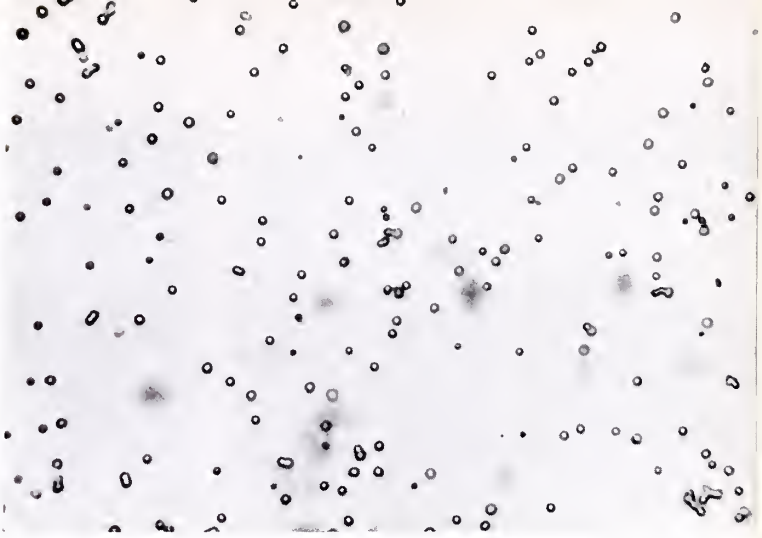
cabbage looper, tent caterpillar and red-banded leaf roller. In addition, there are indications this material may be useful as a larvicide for house fly and mosquito control.

Group 2, Control in One Week

There are a great many diseases of insects caused by virus, bacteria or fungi which can be included in this group. Of these, however, relatively few have been extensively studied and none are available from a commercial source. In contrast to *B. thuringiensis* which can be readily grown on artificial media, insect viruses, to date, can be produced only in the insect which they attack in nature. Despite this drawback, sufficient quantities of virus have been produced to treat thousands of acres of timber in Canada and the United States to control the European pine sawfly with outstanding success. Equally successful field experiments have been conducted with a virus disease for control of the alfalfa caterpillar in California and with a similar disease to control the cabbage looper in California and New York.

In each of these examples, the nature of the insect-plant feeding association is such that some feeding can be tolerated. The cabbage looper, for example, deposits its eggs mainly on the lower leaves of the plant and the young larvae feed there for several days before moving to that part of the plant which will ultimately reach market. It so happens that the polyhedrosis virus of the cabbage looper will kill this insect in 4 or 5 days (at 70°F. temperature or above). Thus, if the virus is applied to the lower leaves where the young larvae feed, appreciable economic damage is prevented.

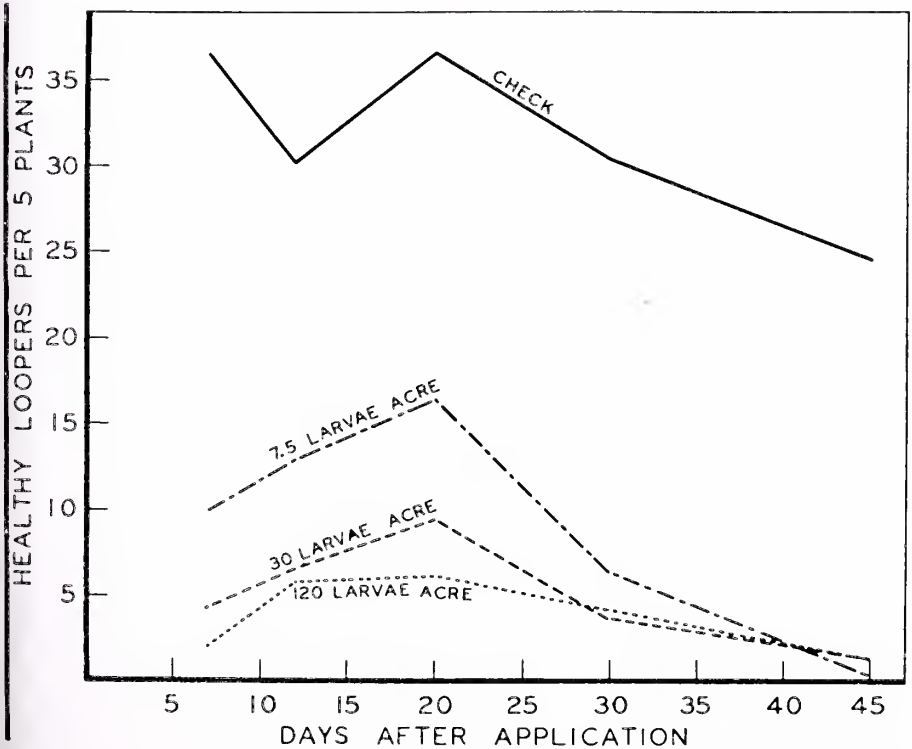
The polyhedrosis virus of the cabbage looper is highly pathogenic. Repeated tests have shown that it can be artificially disseminated in regular spray equipment using the macerated bodies of diseased larvae (left). As little as 5 or 10 diseased larvae per acre will provide control (see graph). This at first appeared to be an exceedingly small dosage, but subsequent research has shown that some 8



Microscopic view of virus - containing polyhedra in blood of cabbage looper infected with polyhedrosis virus

billion virus-containing bodies (polyhedra; hence the name polyhedrosis) may occur in each diseased larva (above). This means that in spraying at a dosage of 5 to 10 caterpillars per acre, some one to two million polyhedra are deposited per square foot. Since less than 100 polyhedra will cause infection and death of the insect, the adequacy of the dosage indicated is readily apparent.

Following death of the virus-infected cabbage looper, the body wall becomes



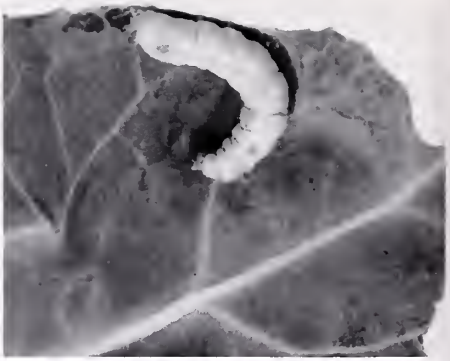
New York Experiment Station

Graph showing control of cabbage looper on cauliflower with a virus disease using 7.5, 30, and 120 diseased larvae per acre in a low gallonage spray

Healthy larva of cabbage looper

fragile and breaks to release the disease polyhedra in a fluid mass (illustrations on this page). This mass is usually deposited on the foliage where succeeding rains and wind distribute the virus in various directions. Thus, each insect which dies of the disease increases the concentration of virus on the crop foliage. While virus deposited in this way may not be uniformly distributed, especially on newer foliage, it means that one or two applications of the virus may provide control of the insect for an entire season.

Larva of cabbage looper killed by polyhedrosis and hanging limp on foliage (left); body wall breaks to release virus-containing body fluid (right)



Larva of cabbage looper infected with polyhedrosis. Note jaundiced appearance in contrast to healthy larva

Group 3, Control Next Year

A great many diseases of insects show promise as a means of providing long-range reduction in population of pest species. In most cases, supplemental control with chemical insecticides also will be necessary because of the nature of the injury caused by the insect. We can include in this group diseases of many of the lepidopterous insects which feed in or on fruit, the European corn borer, corn earworm and many others. For example, the red-banded leaf roller, one of the major apple pests of the Northeast, is subject to a virus disease called granulosis (page 75). This disease often occurs in nature but can also be artificially induced by collecting the virus from diseased larvae and spraying this over the apple foliage. Field tests have shown that such an application of virus can bring about a complete kill of the insect. In spite of this fact, the fruit crop may sustain appreciable damage from the red-banded leaf roller (page 75). There are two reasons why this is so. First, the virus is rather slow acting and under field conditions may require 30 days to kill the insect. Second, the red-banded leaf roller feeds directly on the apple fruit. Obviously then, within 30 days, a great deal of damage may occur.

While it may at first seem that this type of disease-insect relationship does not appear too promising as a method

of control, the indirect or long-range effects should not be overlooked. Since the abundance and destructiveness of any insect in a given season is dependent, in part, on the number that survive the winter to start the new brood, any factor which significantly reduces the overwintering population should not be disregarded. It might also be pointed out that while the milky disease of the Japanese beetle acts slowly, this organism has effected a gradual lowering of the population level of the pest in certain areas to the point where it has become of minor importance.

Advantages and Disadvantages of Microbial Control

Until an insecticide has been widely tested under field conditions, advantages or disadvantages of its use must be largely speculative. There is one obvious advantage of microbial insecticides, however, which warrants mention in this connection.

So far as is known, organisms which cause disease in insects and which might become microbial insecticides are noninjurious to other forms of life. This feature of safety in use is especially attractive at the present time when toxic residues in foodstuffs are so much in the limelight. In addition, the safety to the person applying the insecticide cannot be overlooked. This is true especially in the home garden type operation where the applicator is often less familiar with the care required in handling dangerous materials than is the commercial grower.

What of the Future?

The exploitation of insect disease organisms for commercial purposes has barely begun. One has only to observe field populations of insects devastated by disease to realize what a potent tool we may have to protect our crops from insect attack. Much research is needed to determine which of the hundreds of insect disease organisms now known will best serve in practical use. Some one hundred entomologists and bacteriologists

Red-banded leaf roller larvae: (left) healthy, (right) infected with granulosis

at universities, private institutions, and state and federal research centers throughout the world are currently involved in the study of insect diseases. In addition, many scientists in industry are similarly engaged. Not all of the organisms studied will find a place in our applied insect control programs. Many of us confidently expect, however, that certain microbial insecticides will help provide safe and efficient insect control in the not-too-distant future.

Injury on apples caused by red-banded leaf roller

Photos New York Experiment Station

SOME NEMATODE ENEMIES

Certain fascinating fungi and some cannibalistic nematodes are our allies in the fight against these pests

Waldimero Coscarelli

RECENT surveys indicate that crop and plant damage due to nematode infestation results in an appalling loss of agricultural revenue. The annual loss due to these worrisome worms in New Jersey alone is conservatively estimated at 15 million dollars.

Of the hundreds of different types of nematodes that live in soil relatively few are harmful to crops, but if the development of these few is allowed to go unchecked total crop destruction may result. Fortunately, soil fumigants are able to control nematode development but in many cases the cost of fumigation is prohibitive. It is possible to reduce losses and prevent the spread of nematode infestations by crop rotation and breeding programs, but the control measures devised by man are not as intriguing as nature's own methods of limiting the activities of nematodes in soil.

The abundance of microorganisms in nature is carefully controlled by a system of checks and balances. When the population of one organism increases it is usually at the expense of another, but most often the effect is temporary and the balance is soon restored. Under conditions that favor the development of nematodes their numbers will increase. As a consequence, there will be an increase in organisms that prey on nematodes. Crop-destroying nematodes are preyed upon by carnivorous cousins and by a group of remarkable microscopic molds that are able to capture living worms by means of traps formed in response to the presence of their prey.

Cannibalistic Nematodes

Some of the cannibalistic nematodes are less than one-twenty-fifth of an inch long and difficult to see without the aid of a microscope; however, they are very prolific. When cultured under laboratory conditions they grow and multiply more than one-thousand fold in two weeks. They capture and feed on other nematodes by means of a stylet. The stylet arises from the mouth, and is used to pierce the prey, and as a hypodermic needle to inject paralyzing saliva. The saliva also serves to digest the victim's body contents, which are sucked through the stylet as through a straw and used for food. Species of the cannibalistic nematode *Mononchus* are capable of destroying large numbers of plant parasite nematodes, including members of the *Ditylenchus* and *Heterodera* groups which parasitize onions, beets, potatoes, tomatoes and clover.

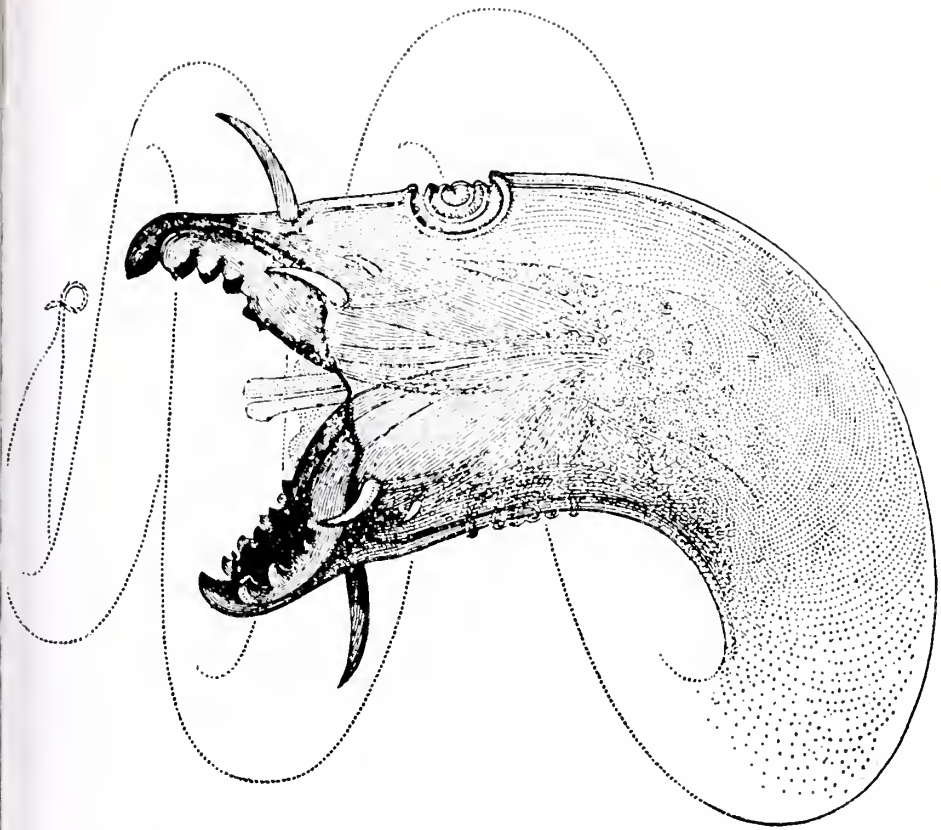
Mononchus has a life span of only 12 weeks but during this time it is capable of destroying 1300 nematodes, sometimes killing as many as 80 in one day.

Worm-catching Fungi

More remarkable than the cannibalistic nematodes are the worm-capturing microscopic molds known as nematode-trapping fungi. They are tiny carnivorous plants dwarfed by the size of their prey but able to trap, kill and consume nematodes. Since the existence of nematode-trapping fungi has been known for almost one hundred years it is surprising that they have received so little attention.

The methods employed by these fungi to trap nematodes vary with the species. Some act on a fly-paper principle whereas others are best compared to a rabbit snare. Both are deadly in that once a nematode is caught it seldom escapes but serves as food for the fungus.

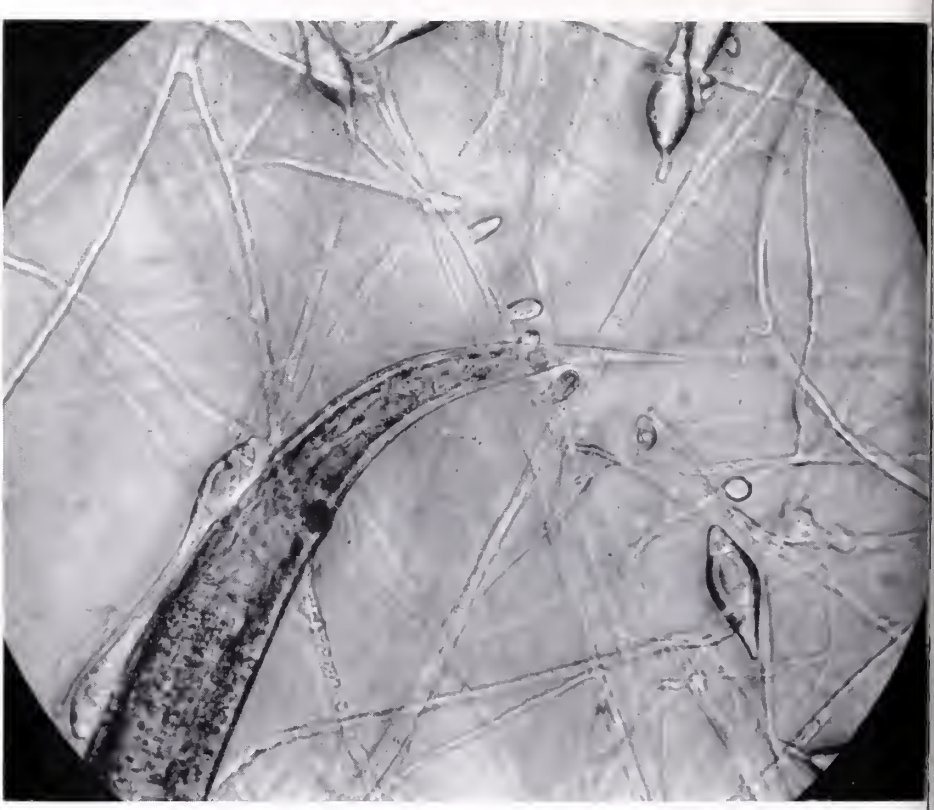
Some fungi capture nematodes on small spherical knobs. The surface of these



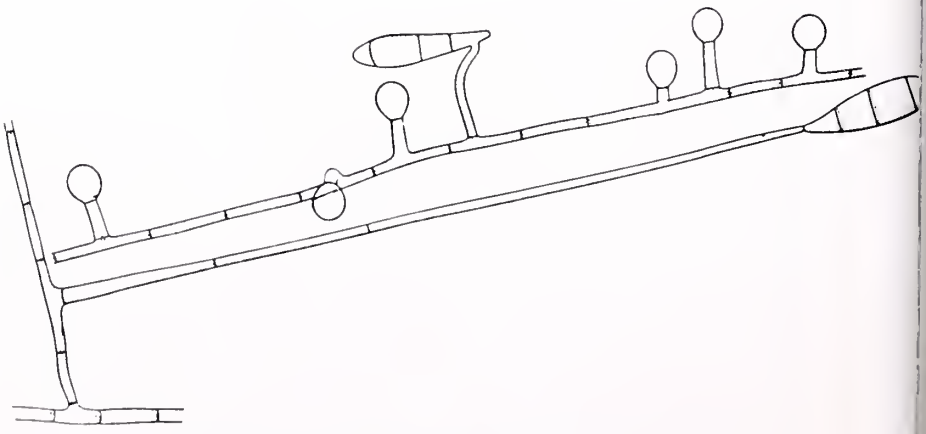
A shark nematode, so named because of the rows of ferocious-looking, backward-pointing teeth with which its jaws are armed. This rapacious little monster preys on other nematodes

knobs, which are sometimes called "lethal lollipops," is coated with an adhesive substance that is so sticky that momentary contact is usually enough to doom the nematode. Other carnivorous molds produce ring traps. Some rings are able to constrict whereas others are not. The non-constricting rings tend to fuse together, forming an elaborate network of loops coated with an adhesive. A nematode attempting to pass through becomes stuck and in attempting to escape usually becomes further entangled in the network. Constricting rings are composed of three cells and act as rabbit snares. When a nematode wanders into the opening of a constricting ring the cells inflate in less than one-tenth of a second to three times their normal size, gripping the worm so that it cannot escape. Of particular interest is the fact that the carnivorous molds do not usually form their traps in the absence of prey. In this respect they are unique and differ markedly from the insect-capturing higher plants.

The occurrence of predaceous nematodes and fungi in soil is more widespread than generally known. The addition of nematode-trapping fungi to plants in soil containing infective worms has reduced the severity of infestation. These results are indeed promising but our present knowledge is not sufficient to evaluate the importance of nematode predators in nature or to permit us to exploit their activities for the control of nematode diseases.

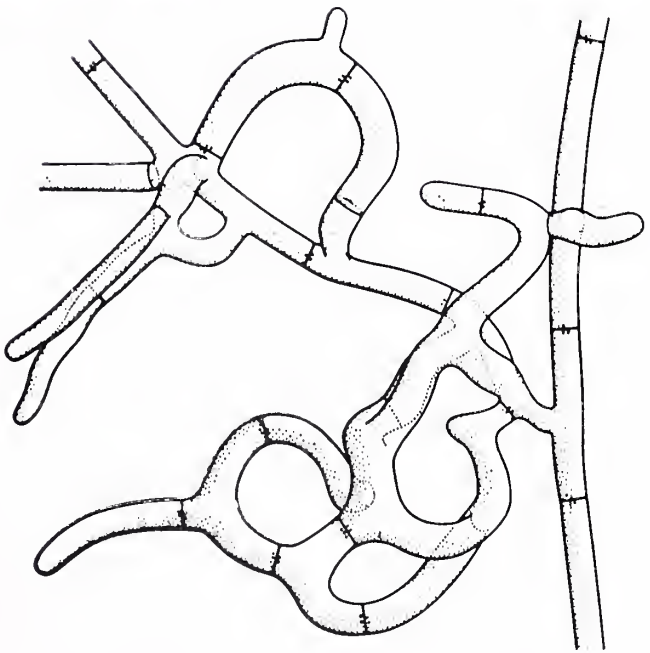


Tail of nematode is held firm by sticky knobs, "lethal lollipops," of predaceous fungus
Large spindle-shaped objects are spores

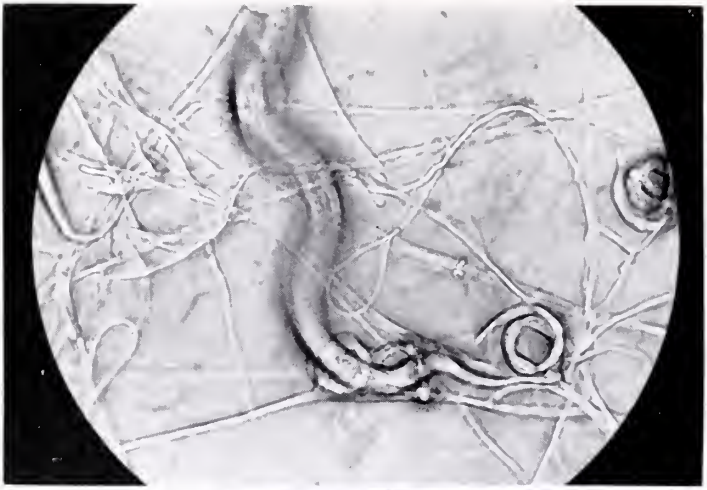


Drawing showing adhesive knobs of predaceous fungus

Above, network of non-constricting rings formed by another predaceous fungus



At right, drawing of non-constricting rings of fungus

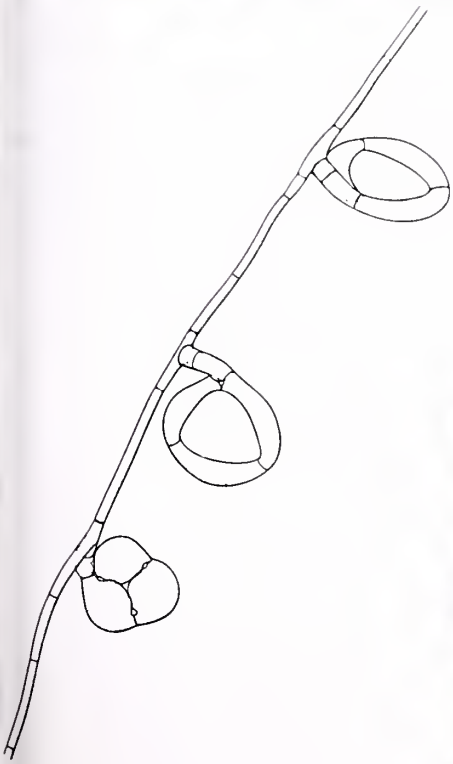


Wandering nematode worked its way into two non-constricting rings, and though held firmly, was struggling to escape when picture was taken

Captured nematode desperately attempting to escape from two non-constricting rings that encircle its body

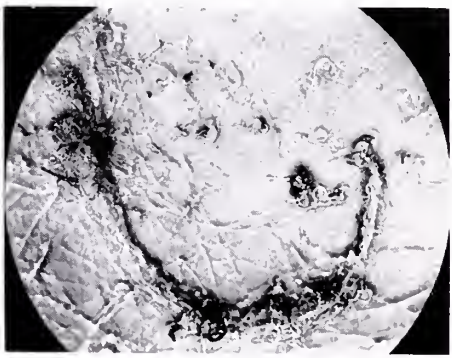
Dead nematode and numerous non-constricting rings in which it was captured

Above, nematode captured by constricting ring. Also shown are number of open traps and one closed ring



At left, drawing of open and closed constricting rings

Dead nematode almost completely decomposed. A considerable number of new traps were formed by fungus as it fed on its prey



USE OF RESISTANT VARIETIES—THE IDEAL WAY TO CONTROL INSECTS

Reynold G. Dahms

THERE is no more economical or desirable way to control insects than through the use of plant varieties that resist their attack. Resistance can be combined with other desired qualities and maintain control without cost to the grower, without creating a residue or other toxicological hazard, and without damaging pollinating insects or upsetting nature's balance between insects and their natural enemies.

The spectacular success of organic insecticides since World War II has obscured the fact that there are many other ways of control. However, the increasing number of insects that have become resistant to insecticides and the public concern about residues have caused many entomologists to consider all possible means of insect control. One method gaining attention is the development of insect-resistant crop plants.

Differences in the ability of varieties of crops to produce satisfactory yields in the presence of insect infestations have been recognized for many years. As far back as 1788 Isaac Chapman recommended growing wheat varieties having an early growth habit in order to reduce damage by the hessian fly, *Phytophaga destructor* (Say).

Classic Example

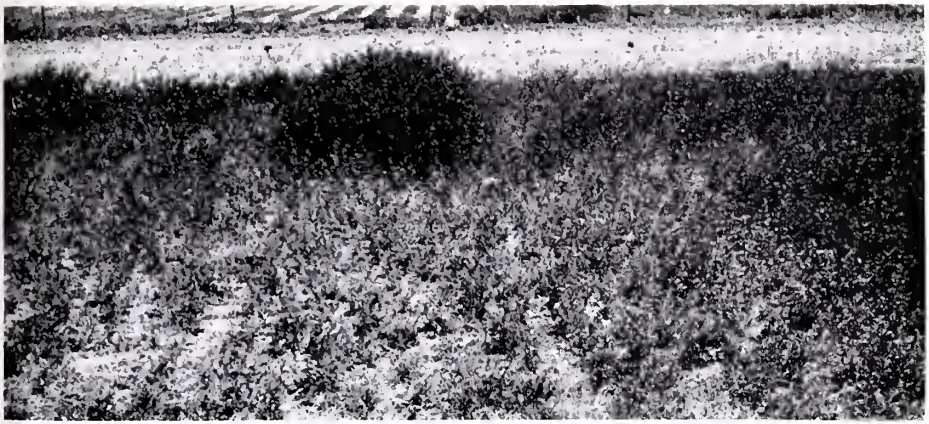
The classic example of insect control by the use of resistant varieties is that of the grape phylloxera, *Phylloxera vitifoliae* (Fitch). In 1860, 25 years after this insect had been introduced into France from America, it had destroyed nearly one-third of the vineyards in tha country and threatened the entire grap industry in Europe. The grape phylloxer is indigenous to eastern United State and native grapes growing in this are had developed complete immunity to it attack. The grafting of European grape on resistant rootstocks from easter United States gave complete control an saved the grape industry of Europe.

For several years breeding for insec resistance has been a major part of th insect-control program of many cro plants. Results of this work have bee very encouraging. World-wide collection of plants have been screened. Insect re sistance of more than 100 species plants has been recorded. These includ such diverse crops as alfalfa, apple, bea cabbage, celery, clover, cotton, cranberry grape, grapefruit, grass, maize, oat potato, rice, sorghum, squash, sugar bee sugarcane, tobacco, turnip, vetch, an wheat. Painter reported that 38 insec resistant crop varieties were growing o farms in the United States in 1958. Se eral additional resistant varieties hav been released since 1958, and others hav been used in breeding programs but d not possess all the desirable qualities f release.

How Resistant Varieties Are Obtained

Four general procedures are used obtain insect-resistant varieties:

1. Introduction of varieties that provi greater resistance than those existi locally.
2. Selection of resistant strains



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Lahontan alfalfa, resistant to spotted alfalfa aphid grows in plot in background; other varieties are susceptible and show aphid damage

sometimes an individual plant from existing varieties.

3. Hybridization of resistant plants with those not resistant but possessing otherwise desirable agronomic characters, followed by selection in the segregating generations.

4. Grafting otherwise desirable but susceptible scions on the rootstocks of resistant varieties.

In any of these procedures best progress can be made by the team approach, where the entomologist, agronomist, horticulturist, plant pathologist, and plant breeder work together. To be worthy of release a variety must have other desirable attributes in addition to insect resistance, such as disease resistance, superior quality, and high yielding ability. Since genetic segregation for all characters occurs simultaneously, it is undesirable to limit a breeding program to insect resistance alone. Frequently it may be advantageous to select varieties for release that have a fair degree of insect resistance combined with other desirable characteristics in preference to those having only high resistance.

Cause of Insect Resistance

The cause of plant resistance to insects is usually complex and varies with each insect and crop. Painter suggested three interrelated factors which influence insect resistance—(1) nonpreference, (2) antibiosis, and (3) tolerance. In any given variety any one or all of these factors may be present, and determination of the proportion of resistance caused by each is important.

Nonpreference denotes plant characters that cause insects to avoid a plant for oviposition, food or shelter. It may be due to either a lack of attractive stimuli within a plant or to the presence of a repellent.

It is generally considered that nonpreference alone can give rise to only a low level of resistance. A nonpreferred variety may be injured only slightly when grown adjacent to a preferred variety, but the results will be quite different if the only plants available to the insect are of the nonpreferred variety. However, there are many examples in which the nonpreference stimulus is so strong that insects will die without feeding or depositing eggs if a suitable host variety is not available.

The term **antibiosis**, first proposed by Painter in 1941, is used to describe those adverse effects on the insect development that result when a resistant host plant is used for food. The effect may be reduced fecundity, decreased size, abnormal length of life, or early death.

Antibiosis is usually thought to be

brought about by the lack or insufficient quantity of some nutrient in the plant necessary for insect development. However, specific chemicals, including toxins, may often be responsible. For example, Beck has shown that certain chemicals found in resistant corn hybrids may act as toxins to the European corn borer, *Pyrausta nubilalis* (Hbn.).

The correlation of antibiosis in resistant varieties to the general population levels of the insect involved may often be overlooked. Varieties on which insects feed may exert a profound influence on their fecundity and other biological processes. For example, the spotted alfalfa aphid may produce about thirty offspring per week on a susceptible variety whereas on resistant plants this aphid will produce only four or five.

Thus resistant varieties may cause a degree of sterility of the insect population. Knipling has shown theoretically that inducing sterility of the natural animal populations by chemicals or other means would be more effective than releasing a dominant number of sterile males as was done in the successful eradication of the screw worm, *Callitroga hominivorax* (Cqrl.), in the Southeast. (See article by Bushland on page 88).

One of the most striking examples of the effect of resistant varieties on the insect population over a wide area was reported by Suneson and Noble with the hessian fly in California. In 1944 and 1945, after about 15 years of crossing, backcrossing, and selecting by workers in the U. S. Department of Agriculture and the California Agricultural Experiment Station, two soft white wheats, Big Club 43 and Paso 42, resistant to the hessian fly, were released in areas in California where plant injury by the fly was serious. By 1946 further research on control of this insect was unnecessary because it was no longer a problem. The success of the program was obvious since from 1920 to 1944 infestation levels of 50 to 100 percent of the plants had been recorded each year. Now even susceptible varieties grown on small acreages in these areas have low infestation rates.

A similar situation involving the hessian fly was reported in central Kansas where the moderately resistant variety Pawnee was released in 1943. By the fall of 1946 Pawnee was the predominant wheat grown in central and eastern Kansas. Since 1948 there has been almost no evidence of the hessian fly even in the most favorable locations. The reduction of populations has occurred even though, in most of the years, much of the acreage has been seeded to susceptible varieties.

Thus the effect of antibiosis in resistant varieties is cumulative. A variety that causes a reduction in the insect population of 40 or 50 percent each generation may eliminate the necessity for chemical control. Other natural forces may further reduce the insect.

Tolerance is the ability of a plant to withstand a heavy insect infestation without serious permanent injury. Nonpreference and antibiosis are primarily brought about by insect response, whereas tolerance is a response of the plant. Therefore, because of environmental differences, tolerance may be more subject to variation.

The general vigor of the plant at the time of the insect attack may affect tolerance. Thus hybrid vigor, or heterosis, shown by first-generation sorghums, increases the tolerance to chinch bugs. However, vigorous plants or those growing in fertile soil are not always attacked less by insects. Each host variety and each species of insect constitutes a separate problem. The European corn borer, for example, usually chooses the most vigorous plants on which to deposit eggs. Painter* listed 14 references in which experimental evidence indicated that high fertility or high nitrogen in the soil increased insect injury, and 9 in which the reverse was true.

Some varieties are able to recover from injury more rapidly than others. Cimarron

*Painter, Reginald H. 1951. *Insect Resistance in Crop Plants.* 520 pp. The Macmillan Company. New York.

oats may be injured severely by greenbugs, *Toxoptera graminum* (Rond.), but when the infestation is removed this variety recovers much faster than many others and may make a satisfactory yield. Certain corn varieties are able to stand up and hold ears under heavy second-brood European corn borer attack whereas others lodge and lose ears. Tolerance may be due to the plants being unaffected by toxins injected by insects. For example, Chatters and Schlehuber in studies of the difference in injury to plant cells of barley, oats, and wheat by the greenbug, found that lysis, probably caused by toxins, was more apparent in barley than in wheat.

Physical characteristics. The physical characteristics of a plant may also influence insect resistance. Pubescence (hairiness) has been indicated as the cause of alfalfa, clover, soybean, and cotton resistance to leafhoppers. Solid-stem wheats are usually resistant to the wheat stem sawfly, *Cephus cinctus* (Nort.). Hardness, thickness, and toughness of tissues have been shown to be responsible for resistance in some plants. Length and tightness of husks are important in reducing damage by the corn earworm, *Heliothis zea* (Boddie).

Progress in Development of Resistant Vegetable Varieties

Although the major effort to develop insect-resistant crops has been with grain and forage, enough progress has been made with vegetables to indicate promise. Beans, cantaloupes, collards, sweet corn, onions, peppers, potatoes, and squash are some of the vegetables being studied for insect resistance.

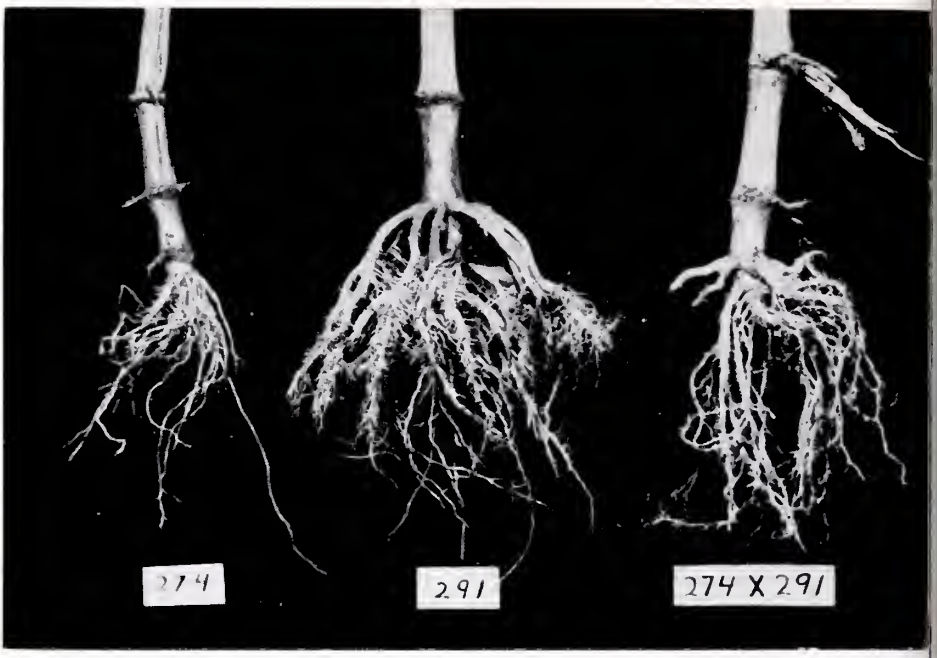
The development of corn earworm resistance in sweet corn has been especially encouraging. Some of today's hybrids have only 10 to 15 injured kernels per ear in contrast with 22 to 25 in Golden Cross Bantam. Experimental hybrids have been tested that approach immunity.

Perhaps the most spectacular form of resistance so far observed in corn was first found by R. A. Blanchard in 1941 in a line of flour corn. He observed dead larvae of the corn earworm in the silks. Since Blanchard's discovery, selections from sweet corn x flour corn have been found which carry the lethal factor. The same or a similar lethal factor has been located in a corn x teosinte x sweet corn cross and from sweet corn x Mexican June, a semi-flint variety. The lethal factor appeared to be dominant in these three lines. Thus when either or both parents in a cross had the factor it nearly always showed up in the progeny. For example, 40 percent of the ears from one such cross had dead larvae. In 1959 Purdue Agricultural Experiment Station released two sweet corn inbred lines that showed this lethal factor. It is not known whether it is a toxic substance in the silk or the lack of some nutrient essential to the corn earworm larvae.

Progress has been made in the development of sweet corn inbreds resistant to the European corn borer. In 1948 Schlosberg and Baker reported some resistance in 44 out of 977 inbreds tested. Thirteen of these 44 inbreds were already in commercial use.

Observations have been made on the resistance of corn to rootworms. Tolerance of some strains has been demonstrated by their ability to develop new roots above the point of injury almost as fast as the larvae eat off the roots. Susceptible strains lodge easily and produce poorly filled ears. Pollination may be affected adversely when lodging occurs at or before tasseling.

Considerable work has been done toward developing varieties of Irish potatoes resistant to insects. Varieties of potatoes or other species of *Solanum* have been reported resistant to at least 14 species of insects. The variety Sequoia released in 1939 has shown considerable resistance to leafhoppers. Workers in Europe have reported that certain potato varieties have a low level of resistance to the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). The variety Doe Bay Red was resistant to the tuber flea beetle, *Epitrix tuberis* (Gent.), in the State of Washington.



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Differences in damage to corn roots by northern corn rootworm: Inbred 274 susceptible 291 resistant, and cross 274 x 291 intermediate

Biological Races

The permaneney of insect resistance must be considered when the value of this method of insect control is being determined. When a resistant variety is grown over a large area, how long will it be before strains of inseets evolve that can attack it? With the widespread development of insect resistance to insecticides, entomologists have become aware of biological races. Plant pathologists are continually encountering new races of fungi that are able to attack varieties of crops that were previously resistant.

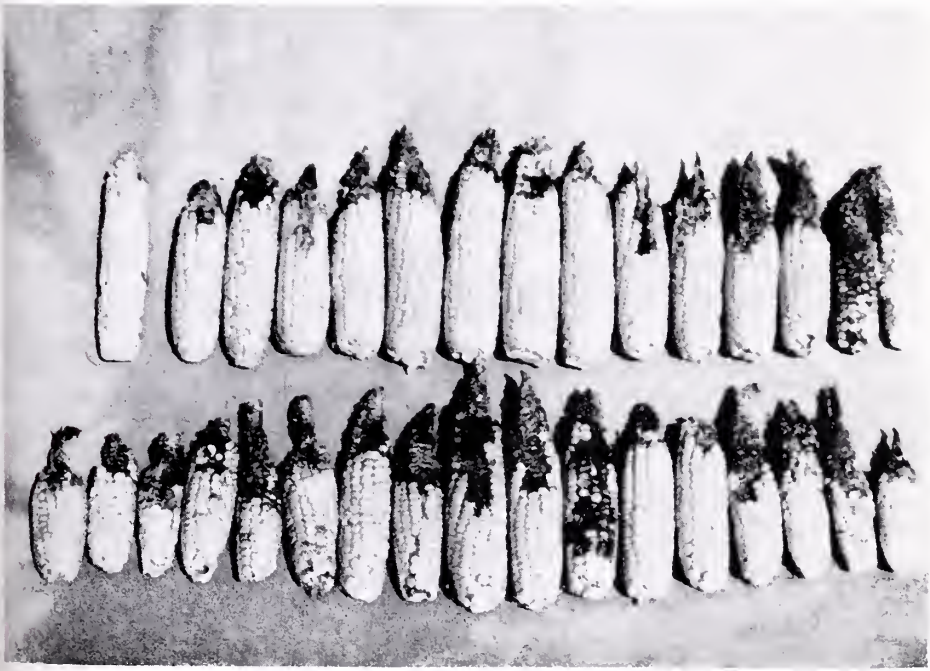
In studies of wheat resistance to the hessian fly, Gallun isolated four races of this insect, some of which were able to develop on varieties that were resistant to hessian flies found in the field. Painter showed that there two strains of this fly in Kansas, one of which was able to infest Pawnee wheat. However, in spite of these strains Pawnee has maintained a satisfactory resistance in this state for almost 20 years. Even though the development of biologieal raees eapable of infesting formerly resistant crops has not been widespread, every effort should be made to develop crop varieties that are resistant to these races. If new races develop or are found, all available plant varieties should be screened for resistance to them.

Future Possibilities

In the past the major efforts in developing resistant varieties of plants have been for the control of insects for which no effeetive chemical eontrol was yet available or in places where the value of the erop was so low that the use of insecticides was not economical. The progress has been so encouraging that undoubtedly research will be increased to develop varieties of vegetables and ornamentals that resist insects. Such work should be encouraged since it is one method acceptable to both wildlife enthusiasts and biological control personnel

Two sweet corn hybrids grown side by side without insecticides for corn earworm control; strain above was resistant, one below susceptible

E. V. Walter



U.S.D.A.

Screw-worm flies are bluish-green in color and about twice the size of house-flies

INSECT ERADICATION BY MEANS OF STERILIZED MALES

An unusual new technique holds great promise as a method of control

Raymond C. Bushland

IT may seem strange for a publication devoted to the interests of plant growers to have an article dealing with a livestock insect. However, this is the story of a new method of insect control which will have far-reaching effects. The male-sterilization technique is now being investigated in research on the control of other insects, and some day this new method of biological control may be utilized to eradicate a garden pest.

Sterilization with Gamma-rays

The use of sterilized males is a unique procedure. Insects are grown in the laboratory and sterilized with gamma-rays, and the males are released in nature to outnumber native males and

Editor's Note. Dr. Bushland was co-recipient with Dr. E. S. Knipling, in May, 1960, of the $10,000 Hoblitzelle National Award in the Agricultural Sciences for developing the "male-sterile" technique discussed in this article.

About 250 eggs are laid at a time on wounds of warm-blooded animals

U.S.D.A.

Larvae hatch from eggs and feed on animal, eventually killing it if untreated

overwhelm them in competition for mates. The "wild" females that mate with sterilized males cannot reproduce, so that in the next generation there are even fewer normal insects. By maintenance of a constant rate of release of sterilized males, each succeeding generation is further outnumbered by the sterile males until eradication results. How this scientific principle works is illustrated by the fate of the screw-worm fly in the Southeastern States.

Control of Screw-Worms

Screw-worm flies look like blue blow flies, but the larvae are quite different from the maggots that breed in decaying flesh. Screw-worm larvae are obligatory parasites on warm-blooded animals; they grow only in wounds and feed on living tissues. They attack wild animals, such as deer, raccoons, foxes, and rabbits, but they cannot reproduce in small animals such as rats and mice because they kill the host before they can complete their development. They are the most destructive insects affecting livestock in the South.

On the opposite page are shown two adult flies. The male on the left is distinguished by large eyes that touch at the top.

When the insects are 2 days old, they are ready to mate, and by the age of 4 days most of the females in a population have mated. The males mate repeatedly if they can find virgin females, but the females mate only once.

When the female is a week old she seeks a wounded animal on which to deposit her eggs. Any sort of break in the skin may attract the fly. The navels of new-born animals are particularly susceptible. The eggs are shown above, left. The female lays a mass of about 200 eggs on the edge of a wound which hatch within a day.

The larvae (above, right) burrow into the flesh and feed on the living tissues. Those from one egg mass make a hole about the size of a lemon, which is sufficient to kill a small animal. The infested wounds attract other ovipositing flies, so that if they are not treated with insecticides, thousands of larvae may attack the animal within a few days, literally eating it alive.

The larvae complete their growth after feeding 5 to 7 days. Then they crawl from the wound, fall to the ground, and burrow in the soil. Within a few hours they transform into pupae (see page 90). In warm weather this stage lasts about a week, but in cool weather it may be prolonged. Then the flies break open the

Grown larvae drop to ground, burrow into soil, and change to pupae from which mature flies later emerge

U.S.D.A.

pupal cases in the soil, wriggle to the surface where they crawl up onto vegetation, and after a few minutes in which their wings expand and their bodies harden, they fly away.

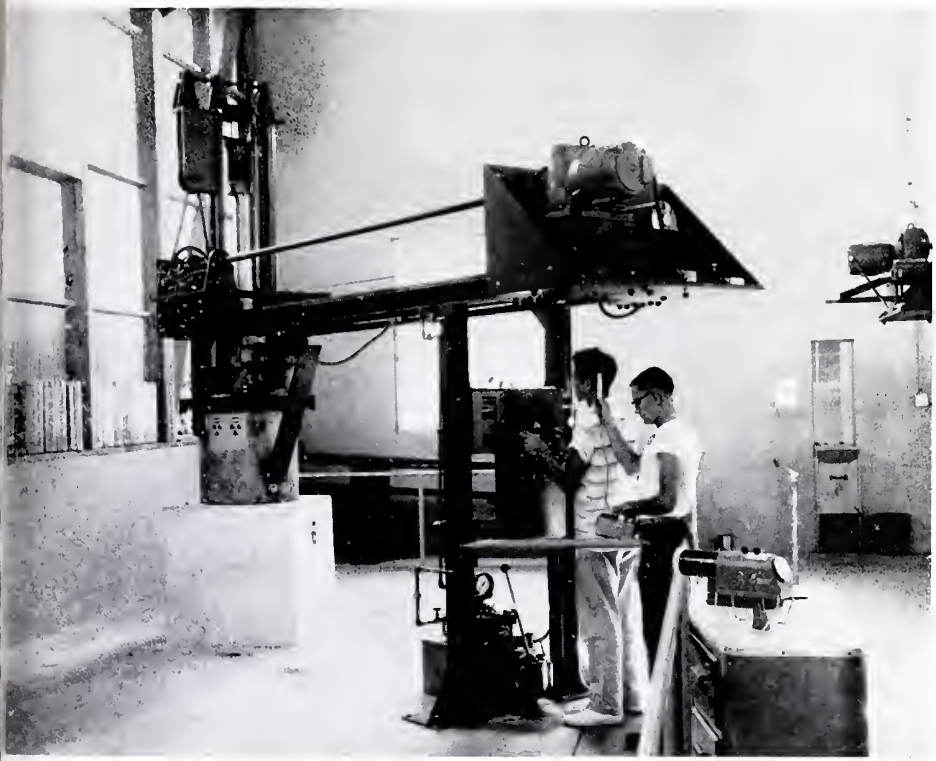
The screw-worm is native to the tropical and subtropical parts of North and South America. Flies survive the winter in southern Texas and spread northward each summer as far as Kansas City, but they do not spread very far east of the Mississippi River and every winter the population is killed back to the Texas overwintering area. In 1933 the insect was accidentally introduced into Georgia, presumably through shipment of infested cattle. It spread down into Florida where the weather is warm enough for overwintering, and a separate southeastern population became established. In summer screw-worm flies migrated into Georgia, Alabama, and the Carolinas. Attempts were made to control this new insect by widespread use of insecticides on domestic animals, but wild animals could not be protected and enough screw-worms reproduced in neglected animals to maintain the population.

First Experiments in Florida

Many years ago E. F. Knipling, director of the Entomology Research Division of the U. S. Department of Agriculture, proposed that this isolated Florida population might be eradicated by release of sterilized males. Since in nature there were not more than a few hundred flies per square mile, they could be outnumbered by sterile flies from the laboratory.

Screw-worms can be easily grown in the laboratory on a mixture of ground meat, blood, and water. The flies pupate in sand, and the adults are kept in cages provided with food and water. They lay their eggs on a warm meat-attractant mixture which simulates a wound.

Geneticists have long used X-rays and gamma-rays to induce mutations in fruit flies for experiments in heredity, and they discovered that overdoses of irradiation may cause sterility. In 1950 Dr. Knipling asked me to investigate the sterilization of screw-worms by X-rays and gamma-rays and to study the effects of sterilizing radiation on vigor, longevity, and mating habits.



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Flies are sterilized in this device by radiation from cobalt-60

It was found that both sexes of screwworms could be sterilized by a dose of X-rays or gamma-rays given to pupae 1 or 2 days before they completed this stage of development. When the adults emerged they behaved normally in all respects, except that they were sterile. The females could not produce eggs. Males produced sperm, but the heredity of the sperm was so changed that eggs from a normal female mated with a sterilized male did not hatch.

Normal females were first mated to sterilized males and subsequently transferred to cages with normal males. The males pursued the females, but mating was never observed. Later when the insects oviposited the eggs did not hatch, proving that the females mated only one time.

Mixed populations of normal and sterilized flies were caged together. When records were taken on the hatching of eggs laid by the normal females, they showed that the proportion of sterile egg masses was the same as the proportion of sterilized males in the cage population, proving equal competition for mates.

Next, field tests were performed on Sanibel Island off the coast of Florida, where sterilized flies from the laboratory strain were released to compete for mates with the native flies. When the native males were outnumbered by sterilized males, the native population declined with each succeeding generation. Eradication could not be proved on this island, because it was not sufficiently isolated from the mainland and it became reinfested by flies migrating from untreated areas.

Success on Curacao

The conclusive experiment was performed on the island of Curacao in 1954.

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Packaging irradiated pupae

This 170-square-mile island 40 miles off the Venezuelan coast was suitably isolated. Native screw-worms were abundant, breeding chiefly in goats which roamed at large over the island. Sterilized flies were released at the rate of 400 males (plus an equal number of sterilized females since it was impracticable to separate the sexes) per square mile per week. During the first weeks after releases 69 per cent of the egg masses laid by the native flies failed to hatch when collected from wounds on goats and brought into the laboratory. After a month of releases the native population was reduced and more than 80 per cent of the collected egg masses were sterile. By the third month only a few egg masses could be found in examinations of wounded animals and none of these hatched. The last egg mass was found after 13 weeks. Eight weeks later release of sterilized flies was discontinued. Screw-worm have never reappeared on Curacao.

During 1955 and 1956 our researc team in Florida developed mass produc tion procedures. M. E. Jefferson, radio logical safety officer of the Agricultura Research Service, in cooperation wit Brookhaven National Laboratory, designe and installed a cobalt-60 gamma-ra source (page 91) that had a capaci for sterilizing 14 million screw-worm flie per week. These flies were packaged a the rate of 400 per box in cartons mod ified from those used for packaging fro zen foods (above). Airplane equipmen (page 93) for opening and distributin the boxes was developed.

In 1957 a pilot test was performed i central Florida in cooperation with th Animal Disease Eradication Division o the U. S. Department of Agriculture an the Florida Livestock Board. This te

proved that it was possible to maintain sustained releases of millions of sterilized flies per week over thousands of square miles of infested land and that the released flies survived in nature to mate with most of the native females.

Following this demonstration, the legislatures of the Southeastern States appropriated funds to match a Federal appropriation. Thus began a Southeastern screw-worm eradication program as a joint effort between the Animal Disease Eradication Division and cooperating livestock agencies of the affected states with technical assistance from the Entomology Research Division.

Beginning in January 1958 the research facilities at our Orlando, Florida, laboratory were expanded, and flies were released to compete with the native population which had been reduced by winter cold. These releases were successful in preventing the usual spring buildup of screw-worms and confined the population to the Florida peninsula.

By July 1958 a huge sterilized-fly production facility was completed at Sebring, Florida. This establishment yielded 50 million sterilized flies per week, which were distributed over all infested areas in the Southeast by 21 light airplanes covering all of Florida and parts of the adjoining states in two-mile swaths each week.

The releases were so effective that less than 1,000 cases of screw-worms could be found in the Southeast during 1958. Most of Florida was freed of screw-worms by the end of the year. The last screw-worms certainly of native origin were found near Miami in February, 1959. One other case of screw-worms occurred only a few miles from the Sebring facility in June 1959. This case may have been of native origin, but it seems more likely that it represented an escape from the Sebring laboratory where a breeding colony of three million normal flies was maintained. Utmost precautions were taken to prevent escape, but the hazard existed in spite of them.

Releases of sterilized flies were terminated in November, 1959, and no infestations of screw-worms have reoccurred in the Southeast.

The U. S. Department of Agriculture maintains inspection stations on principal highways crossing the Mississippi River to examine and treat interstate shipments of livestock to prevent an accidental reintroduction of the pest. In addition, a stand-by colony of screw-worms is maintained at our Kerrville, Texas, laboratory to provide breeding stock for the production of sterilized flies to combat any new infestation that might appear.

Before this eradication program, screw-worms were estimated to cost the livestock industry in the Southeast 20 million dollars annually. In addition, untold numbers of defenseless wild animals were killed by these maggots. This loss has been stopped by a total expenditure of about one-third the money that screw-worms cost Southeastern growers each year. Reintroduction of screw-worms is being prevented at a very small percentage of what used to be the normal annual loss.

Other Possibilities

The Entomology Research Division is considering the sterilized-male procedure for the control of many species of insects that attack plants. The method is adaptable only to special situations. It seems most suitable for use against newly introduced foreign insects to eradicate an exotic species before it becomes wide-

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Loading sterilized flies into plane from which they will be released over infested areas

spread. However, it will also be useful for the control of many established speeies of limited distribution whose numbers may be greatly reduced at eertain seasons of the year. For example, it might be used in the spring against a garden inseet that survives the winter in only small numbers. Also, it might be used against a pest after the population has been brought under control by inseetieides, so that it is possible to outnumber eeonomically the few survivors by sterilized insects reared in the laboratory.

Dr. Knipling has also proposed that it may not be necessary to rear the inseets in the laboratory for sterilization, but that suitable sterilizing ehemieals might be found to be distributed in baits to sterilize most of the males in the native population whieh would then compete with the remaining normal males for mates.

The Entomology Researeh Division is now completing arrangements for praetical field tests on some small Paeifie islands to try the sterilized male technique for the eradication of the oriental fruit fly and the melon fly.

Fruit fly eontrol with sterilized males i eomplicated by the faet that females mat repeatedly. Therefore, one mating wit a released sterilized male does not eom pletely destroy the reproduetive eapaeit of a native female. Also, laborator studies have shown that long-lived male may regain a degree of fertility in thei old age. They do not tolerate a dose o gamma-rays suffieient to sterilize them fo life. In spite of these teehnieal diffieulties experiments with mixed populations o eaged flies have shown that it is possib to produee a high degree of sterility i the males and that a preponderance o these sterilized inseets so reduees th biotie potential of a population that eon trol is effeeted.

Laboratory studies are in progress o sterilization teehniques for a number o inseets affeeting plants. The task requir ingenuity and intensive, highly teehnie experimentation. However, the seientif prineiple was firmly established in screw worm eradieation and its applieation eertain to be of benefit in the future eo trol of some plant inseets.

(*Continued from page* 53)

down the longest pier in the world and entrust my paekage to the ship's doetor. Invariably I would have one or two flat tires to mend on this trip, due to the tack-laying taeties of the natives.

In order to synehronize the sea voyage with the parasite's life eyele, it was deeided to make a half-way station at Kobe, Japan. When it eame time for me to return to Honolulu, I brought along all the breeding stock and had it in my eabin for hourly eare and observation. It took twelve days to reaeh Kobe, where Dr. Akiyama, a Japanese plant pathologist, was waiting with two Wardian eases full of onion thrips, which were taken to my stateroom. As the parasites emerged from their Philippine thrips they were plaeed in the eages of the Japanese thrips and so brought baek alive to the Experiment Station in Hawaii.

By this time the Big Depression ha hit the Islands and so, being a woma and the last one added to the staff, I w quiekly subtraeted from the staff, in spi of the suceessful accomplishment of n mission.

Editor's Note

In the summer of 1932 I met Dr. Do roseky and her "Dauntless Dodge" Yellowstone Park and aeeompanied the on the last lap of their journey hom from the parasite-hunting expediti. Every time we stopped for gasoline, lit boys would look at the Philippine lieen plates and yell "How'd ja get aeross t water?" A year later, with women seie tists still unwanted in depression tim we went into private praetice as "T Plant Doctor." In 1935 the entomologi half of this eoneern became Mrs. Carlet Van de Water and transferred her inv tigations to her own apple farm.—C.

BIRDS AND INSECT CONTROL

Roland C. Clement

DISCUSSION of the role birds play in controlling insect numbers has been plagued by two kinds of sweeping statements. On the one hand, enthusiastic bird lovers have repeatedly stated that insects would rule the earth if birds were eliminated. On the other, somewhat more objective observers, who discover that birds normally eat only 5 to 20% of the insect fauna, pronounce them incapable of controlling insect numbers.

The trouble is that we have only very recently learned enough about these interrelationships to ask the right questions. It should therefore not be surprising that we cannot yet give clear-cut answers. Indeed, we are learning that there can be no clear-cut answer to the over-simple question, "Can birds control insects?"

Let us first look at some of the evidence which has accumulated since 1885, when the Division of Economic Ornithology and Mammalogy of the U.S.D.A. was formed to collect such data. This division was destined to undergo many changes before being finally abolished in the 1950's. A few of the states actually made important studies even before 1885, and among these Illinois' S. A. Forbes and Iowa's F. E. L. Beal are credited with erecting the foundations and scaffolding, respectively, of American economic ornithology. Edward Howe Forbush of Massachusetts, and several workers in the federal division did outstanding work.

The standard method became that of identifying the contents of birds' stomachs collected throughout their range and at all seasons of the year. This gigantic, pioneering research job into the food habits of birds taught us what they eat, but told us relatively little about the effect of these food habits on the population levels of the prey species. Nevertheless, W. L. McAtee, a leading federal investigator in economic ornithology who has an enviable reputation for independent and original thinking, concluded in 1926 that the American literature on the subject contained 109 cases of demonstrable control of insects by birds, and 88 cases of suppression over local areas. It is useless to quibble over the validity of the data in each of these cases. We now need different types of studies to test the conclusions.

These early workers discovered that one half of the food of some 1400 species of American birds consists of insects, and that most of these birds feed their young a diet higher in insects than they themselves eat. A more detailed study by L. A. Rice in 1946 has shown that although birds took about 20% of the insect population in an Illinois woodland during the year, they exerted most pressure against four groups of rather large, soft-bodied insects, and left certain others almost untouched. The same study showed that a wintering flock of robins took five-sixths of the hibernating invertebrates (grubs, etc.) in the leaf litter of the forest floor.

McAtee, who once stated that "good economic tendencies" (if not achievements) are enough grounds for advocating the protection of the natural enemies of insects, also said that a "degree of control necessary to commercial success of a crop is rarely attained as a result of the work of natural enemies," whether parasites or predators. But perhaps this is too conservative a reading of still inadequate evidence.

Dr. Harvey L. Sweetman, in a valuable review of the literature,* placed moderate emphasis on the importance of diversity

*Sweetman, Harvey L. 1958. *The Principles of Biological Control.* Wm. C. Brown Co., Dubuque, Iowa.

(of plants and animals) in the environment, but there is accumulating evidence that here may lie the principal key to natural regulation. Forbush's *Birds as Protectors of Orchards* (1895, revised 1908) pointed this out half a century ago. He showed that black-capped chickadees and other winter resident birds of eastern Massachusetts, feeding all winter in an orchard, if followed by a group of summer resident species, could protect the area against the ravages of the cankerworm, but that the summer birds alone were impotent simply because the insects got too much "head start" if not thinned out as egg masses by winter birds. Forbush stressed that it was diversity of plant life, insects, and birds that set the stage for the most effective operation of predation pressure by birds.

In a study of the Engelmann spruce beetle in Colorado, F. B. Knight (1958) found that three species of woodpeckers are the primary controls of this beetle, reducing its populations from 45% to 98% as woodpecker concentrations increase, and effectively controlling it under normal conditions. When extensive wind damage topples trees, however, the beetle is then out of reach of woodpeckers; is thus able to multiply almost unchecked in such tangles of windblown trees; and may then erupt in epidemic proportions.

In another, man-created example of this relationship between prey species and their bird predators, federal investigators found that the palm warbler and other birds normally provide commercially satisfactory control of the leaf tier in Florida celery fields which adjoin woodlands, but that they cannot effect this control when the fields are so extensive that the birds are unable to reach their centers from the protective cover of a "home base" in the woodland.

This is the modern dilemma in insect control. We have so oversimplified the landscape, in agriculture, in forestry, and in our communities, that the effective overlapping of predator functions has been severely reduced. And our increasing problems with insects make it plain (to a biologist at least) that in trying t substitute insecticides for the natura regulatory roles performed by a comple of parasitic and predatory forms, man trying to do the impossible. We are ver much in the predicament of the man wit a saw and an unsteady table, cutting firs one leg a little to restore balance, the another, and so on and on until onl stumps remain. Because our butchering of the landscape have so upset natura balances that certain insects have gotte out of hand, we naively approach th problem with a panoply of technologica instruments but no ecological insights in to the sins that are being visited upon u Insecticides merely oversimplify the lan scape further by reducing the number c predators and parasites while the targ pests develop resistance!

We know now that the primary contr in insect numbers is weather, first in d termining how many eggs and your shall survive, and perhaps by also reg lating the pressure of predation an parasitism. We know, too, and unfort nately, that the margin of profit whic determines profitable agriculture impos new levels of bearable insect damage crops.

What needs to be recognized now that insect outbreaks are mostly resul of our land-use practices, including ev urbanization, and that though insecticid may prove useful in emergencies, we mu learn to use them as a surgeon's tool i stead of as a bludgeon on the whole lan scape. It is simply not true, though we' been told this from on high, that we mu continue to use present-day broad spe trum insecticides to maintain health a production. The challenge we face is th of learning how to adapt our uses of t land so as to restore diversity and gi Nature an opportunity to do some of t work of balancing populations. This w take time because our heavy-handed tec nologists are not particularly blessed wi the sort of humility this job calls f But we must set about it now, and wh our work is done birds will still be an i portant part of the landscape.

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16 No. 4

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Editorial

CAROL H. WOODWARD, *Editor*

CONSTANCE P. ELSON

and the Editorial Committee of the Brooklyn Botanic Garden

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BROOKLYN BOTANIC GARDEN, BROOKLYN 25, N. Y.

Longwood Gardens: G. Hampfl

The weeping Atlas cedar *(Cedrus atlantica* var. 'Glauca Pendula') in the Gotelli Arboretum, described on pages 8–10. Its trunk is supported by a horizontal pipe eight feet above the ground. From there the branches droop downward like a blue waterfall

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Winter 1960-61

Hundreds of popular and semi-popular articles on gardening and horticulture have appeared during 1960. Our Editorial Committee has read, discussed and deliberated, and has finally selected twenty of these for inclusion in this annual year-end issue of PLANTS & GARDENS. We present them with pride, in somewhat condensed form, and offer our congratulations to the original publishers for their choice, and to the authors for the material. At the same time that we honor them, we thank them for permission to record their work here. Each article makes a contribution worthy of becoming part of the subconscious "information pool" in the back of every gardener's mind. Be sure to read them *all.*

In addition to the above, there are two original articles. One is by Dr. Tomoya Funahashi, who, in six pages, gives us the benefit of his and his father's lifetime experience in the growing of alpine plants in a home garden. This, for many of us here at the Botanic Garden, is the outstanding article of the year. It starts on page 30.

For Alaskaphiles and the many others who love the wilderness, Louise Potter's article on wildflowers will have special charm (p. 36). And for readers interested in bonsai, pages 54 and 55 should have appeal. Just as this issue of PLANTS & GARDENS went to press, 16 other bonsai were received—to be added to the Holsten Collection. We gratefully acknowledge the assistance of Mrs. Hatsuko Goto and Mr. Narimichi Arata in procuring these plants, in Japan, and the help of Mr. Ichiro Goto with correspondence from the New York end.

The three issues now under way for this year:

Fruits for the Home Garden. Edited by George Slate of the New York State Agricultural Experiment Station, Geneva, New York

Japanese Gardens and Miniature Landscapes as the Japanese create them. Edited by Kan Yashiroda of Tonosho, Kagawa-Ken, Japan

Training Plants—Special Forms for Special Uses. Edited by Emily Brown (Mrs. Hillyer Brown) of Burlingame, California.

There is good reading ahead, as well as behind!

Sincerely yours,

George S. Avery

Director

An unusual tree for your collection:

Here's a chance to own the Botanic Garden's fine Flowering Crabapple variety RED JADE—produced here by the late George M. Reed (U. S. Plant Patent No. 1497). Orders sent to the Garden, accompanied by check ($7.50 a tree), will be forwarded at once to the nearest licensed nursery.

TRANSLATING THE JAPANESE GARDEN INTO AMERICAN TERMS*

Reprinted from an article in *House Beautiful*, September 1960**

SUGGESTION is the secret of Japanese gardens.

The Japanese have been solving the problems of too little space and not enough privacy for more than a thousand years. We who are just now having to learn to live on smaller and smaller house-lots can benefit enormously by taking a leaf from the Japanese garden book.

Framing a path, a thatched bamboo gate gives visual depth to the scene. An azalea partially blocks the stroller's view, slows him down, and gives him a sense of a greater distance covered. Artifacts, like the stone lantern, usually are partly obscured by foliage in order to draw the eye toward them

Jeannette Grossman

Adopting their principles and adaptin their techniques to our different climate and terrains, we too can have gardens t make happy the humble, the modest, an the rich, gardens that are sanctuaries fo withdrawal and refreshment. We ca suggest the spaciousness, privacy, mys tery, timelessness, interestingness, and th grandeur of nature in its primitive stat that are qualities of Japanese gardens.

While we tend to mow lawns, edg garden plots, and remove rocks, aimin at an artificial, man-made-looking smooth ness and order, the hand of man is eve more involved in the seemingly wild stat of the Japanese garden which is un mown, unedged, and carefully disordered It is planned to recreate in miniatur aspects of the natural landscape—mour tains and lakes, valleys and stream oceans and forests, interpreted in plant ings, rocks, pebbles, sand, and water.

The Japanese garden is, in fact, on of the most understandable examples o *shibui*—the Japanese concept of beaut in its highest form. The *shibui* garden i man-made with the quiet look of some thing natural. Its colors are nature's ow greens, grays, beiges, and browns, wit rare flashes of the vivid in flowerin shrubs. It has a timeless look, as if i had always existed. It seems never-end ing. It cannot be seen at one glance. I leads the eye and foot around an

*Prepared with the help of David Enge author of "Japanese Gardens for Today (Charles E. Tuttle Co., Rutland, Vermont Publishers).

**Courtesy of *House Beautiful* Magazin Copyright, 1960, by the Hearst Corporatio

through, always suggesting more. It is deeply interesting.

How is it done? Suggestion, mystery, relaxed asymmetry—and the patient hand of man. That is all. But it is so much.

A helpful key to the meaning of the Japanese garden is the fusing of house and environment into an entity. The gradual transition of home to garden is accomplished by links—eaves that hang into the garden, pine branches sweeping up to the house, walks repeating the lines of the building.

The "turning path" is one of the best examples of illusion that suggests mystery and more. Stepping stones so deeply set they seem to emerge from the earth will wind through the garden, allowing the wanderer to stroll, then pause to enjoy a view. Then the path will disappear round a rock or bush suggesting that there is more if one will look.

The path itself may be stones, or many-shaped slabs, or pebbles, or mosaics of tiles, or combinations of these materials—to list a few of the possibilities. It may step adventurously through pools, climb and descend. It always invites the viewer to wander on to see what will happen next. Its winding variety slows the step, making a short distance more intriguing and, therefore, longer.

The Japanese gardener suggests space, using many enchanting tricks played with perspective. Paths will narrow as they go away to imply greater distance. Large, close-to-the-spectator trees or see-through fences obstruct the eye and make the garden appear farther away than it is (this trick of illusion is called *sawari*). Big light-colored leaves close up will make small darker-leafed plants seem farther off in the background. A wall painted a dark color will recede. A natural bark fence may "disappear" altogether. Large rocks in the foreground will make small rocks in the distance seem even more distant.

Borrowed landscape, from a neighbor or the distant hills, is still another way to imply spaciousness.

Interestingness cannot help but happen when the essence of natural materials is intensified. Rocks are placed to accentuate their rocky nature, water placed for the most pleasing contrast, the most interesting reflections, and for its sounds. If the diagonal element in a garden is water, the grading is built up so that the water flows away from the house.

The movement of the water is interesting in itself and adds depth and mystery as it draws the eye away.

In a Japanese garden plants are pruned to emphasize the character of the tree or bush. A plum branch, for example, will be carefully pruned and trained to trail along a path or brush a stone. Pines are pruned to intensify their low, spreading shape. The essence of the plant's nature is revealed by such pruning so the viewer can experience more intimately the interesting individuality of each growing thing in his garden.

A roaming path, with occasional "stopping stones," invites the walker to examine the beauty around him. Thus a stroll becomes a journey in time as well as space. Even on a narrow city lot a meandering path of half-hidden turns that promise mysterious surprises is preferable to a straight line from street to house

Jeannette Grossman

Ezra Stoller Associates

Sawari is the term used when an illusion of greater space is created. *Sawari* is achieved, here, in a limited area, by the closely spaced trees, the trunks of which distract attention and belie the true perspective. Clumps of sheared azaleas give a further impression of distance by suggesting hillocks to the eye

Fences, always of natural materials such as bamboo or bark, mask areas in the garden, create private places, and protect the neighbors. Bushes, too, can fill these functions.

Stone lanterns, and figures, water basins, or an arrangement of rocks add still more to the interest of a garden. The artifact, marked by weather, will be half-hidden by a low-hanging branch, permitting the spectator to discover for himself the man-made accent.

Rocks are arranged like sculpture. They are never placed on top of the ground but deeply set to look as if they had pushed up from below, providing a solid, strong sense of permanence. Rocks are living things to a Japanese for he knows they change with weather and the growth of plants.

The Japanese love the patina of age and encourage it in their gardens by using unpainted wood, allowed—or artificially induced—to weather. Rocks covered with lichens and moss, tiles, rough pottery, twig fences, etc., add to the effect called *wabi* and *sabi*.

David Engel, one of the leading landscape architects interpreting Japanese gardening, says: "Going one step further, granted that a (Japanese) garden has logical, economic, and aesthetic unity, if it still lacks a spiritual unity, it has not achieved its final and best purpose. This is the unity which ties the building to its natural environment, and then links the people who live there to both. It means that in the course of living in our house and garden we become a part of it and it a part of us. This is the unique quality, the ideal of a Japanese garden.'

The sum of all these elements in the Japanese garden adds up to a whole much greater than its parts. Through man's intensification of nature, with planning and care, the Japanese gardener and now, we, too, can achieve the *shibui* garden.

Ezra Stoller Associates

This single magnificent pine achieves its individuality by being pruned to intensify its low, spreading shape. Here, it has been made a dominant landscape feature to be viewed from the house

Steps that disappear around a bend seem to dwindle off into the distance. Large stone at the foot helps to give a feeling of greater depth than actually exists

Ezra Stoller Associates

LIVING WITH DWARF PLANTS

A hobby grows into a fine private arboretum of small and slow-growing conifers

William T. Gotelli

Condensed from *The American Horticultural Magazine*, October 1960
Photographs by courtesy of Longwood Gardens

IN MY aboretum I concentrate only in growing those kinds that are naturally slow growing and the true dwarfs, in preference to artificially produced dwarfs, such as bonsai. The term "dwarf" is relative.

Dwarf and slow-growing conifers may arise naturally in several ways. True dwarfs sometimes arise as seedlings, such as the Pygmy Deodar Cedar, *Cedrus deodara* 'Pygmaea,' Dwarf Douglas Fir *Pseudotsuga menziesi* 'Compacta,' and

W. H. Hodge

At his home at 66 Crest Drive, South Orange, N. J., Mr. Gotelli has assembled perhaps the most remarkable collection of dwarf and slow-growing conifers in the United States. The site of the garden as it stands on the crest of a ridge, within sight of the Manhattan skyline, is a point favoring the growth of his conifers, as Mr. Gotelli points out. Not only is he an indefatigable collector, but the skill used in growing these plants is such as to bring every plant into its full beauty as a garden ornament and as a choice specimen. Mr. Gotelli demonstrates beyond all reasonable doubt the singular effectiveness of dwarf conifers in a landscape planting. His arboretum is open to visitors.

G. Hampfler

Gotelli's weeping blue spruce is a unique form in which the pendent branches have developed a "witch's broom" at the top. Another form of blue spruce (*Picea pungens* var. 'Prostrata,') occupies foreground on opposite page. Ground around specimens is covered with blue stone

he Spreading Omorika Spruce, *Picea omorika* 'Expansa'; others also are known o arise as seedlings.

Propagation: Reproduction from cuttings is by far the best method, since the plant will always maintain its true character as a dwarf. Grafting should be discouraged, since the stronger understock will frequently force more vigorous growth from the dwarf scion to nullify he desired dwarf character.

Culture: Generally speaking, all kinds have grown respond equally to the same ultural treatments. I have provided perfectly drained soil, which is a *must* n growing conifers. The soil in my garlen is slightly acid, a condition to the iking of these plants. I find also that ome of these gems revel in a stony, terile soil. I mulch many of my plants vith "blue stone" chips produced from the native rock of my area. The stone mulch offers insulation and a place for moisture condensation during the warm months, thus cooling the soil surface. When the soil does not become excessively hot, the roots of conifers are more tolerant of severe drought. Practically all conifers prefer sunlight, although the hemlock will thrive in half shade, particularly on north slopes. Transplanting is best accomplished in early autumn or late winter before spring growth begins.

Nutrition: My plants are grown in good top soil, which in my experience produces completely satisfactory results, hence I do very little fertilizing. I have seen instances where a greatly enriched soil has so encouraged rank vegetative growth in dwarf conifers the plants develop quite out of character.

Pests: The dwarf spruces with their closely packed needles seem most suscep-

W. H. Hodge

The creeping Norway spruce (*Picea abies* var. 'Repens') develops a topknot of branches as it matures. Very old specimens may spread to a diameter of 15 feet. A weeping Norway spruce is also seen here

G. Hampfler

Another interesting Norway spruce in the collection is the dwarf 'Maxwelli,' developed about 90 years ago in Geneva, N. Y., and still available at some nurseries. Its needles have hairlike points. The 3-foot specimen above is half a century old

tible to mite infestation. I have found that sulfur dust very effectively controls mite. Fortunately, I have no other serious insect problem in my conifers.

Note: For sources of dwarf conifers, see pages 6 to 8 in the Spring 1960 issue of PLANTS & GARDENS—*Handbook on Trees and Shrubs: Where to Buy Them.*

CHARITY

*Thoughts for those who garden—an excerpt from a chapter in "The Four Loves"**

C. S. Lewis

WILLIAM Morris wrote a poem called "Love Is Enough" and someone is said to have reviewed it briefly in the words "It isn't." Such has been the burden of this book. The natural loves are not self-suffieient. Something else, at first vaguely described as "decency and common sense," but later revealed as goodness, and finally as the whole Christian life in one partieular relation, must come to the help of the mere feeling if the feeling is to be kept sweet.

To say this is not to belittle the natural loves but to indieate where their real glory lies. It is no disparagement to a garden to say that it will not fence and weed itself, nor prune its own fruit trees, nor roll and eut its own lawns. A garden is a good thing but that is not the sort of goodness it has. It will remain a garden, as distinct from a wilderness, only if someone does all these things to it. Its real glory is of quite a different kind. The very fact that it needs eonstant weeding and pruning bears witness to that glory. It teems with life. It glows with eolour and smells like heaven and puts forward at every hour of a summer day beauties which man could never have created and eould not even, on his own resources, have imagined. If you want to see the difference between its contribution and the gardener's, put the eommonest weed it grows side by side with his hoes, rakes, shears, and packet of weed killer; you have put beauty, energy and fecundity beside dead, sterile things. Just so, our "deeeney and common sense" show grey and deathlike beside the geniality of love. And when the garden is in its full glory the gardener's eontributions to that glory will still have been in a sense paltry eompared to those of nature. Without life springing from the earth, without rain, light and heat descending from the sky, he could do nothing. When he has done all, he has merely eneouraged here and discouraged there, powers and beauties that have a different source. But his share, though small, is indispensable and laborious. When God planted a garden He set a man over it and set the man under Himself. When He planted the garden of our nature and caused the flowering, fruiting loves to grow there, He set our will to "dress" them. Compared with them it is dry and cold. And unless His grace comes down, like the rain and the sunshine, we shall use this tool to little purpose. But its laborious—and largely negative—serviees are indispensable. If they were needed when the garden was still Paradisal, how mueh more now when the soil has gone sour and the worst weeds seem to thrive on it best? But heaven forbid we should work in the spirit of prigs and Stoics. While we hack and prune we know very well that what we are haeking and pruning is big with a splendour and vitality which our rational will eonld never of itself have supplied. To liberate that splendour, to let it become fully what it is trying to be, to have tall trees instead of serubby tangles, and sweet apples instead of crabs, is part of our purpose.

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I BELIEVE IN EVERGREENS BECAUSE:

Molly Adams

Their foliage is lustrous. Although greens predominate, there is no monotony because of the many tones and the tints of other colors such as purple, yellow, and blue. Texture contrast is achieved by placing large and small-leaved types together, as shown here with American and Japanese holly

Harry G. Heal

Some have beautiful flowers Among the broad-leaved ever greens, some shade-loving kind have noteworthy flowers in a var ety of colors. Above are the whit blossoms of Japanese andromed (*Pieris japonica*)

They do well as foundation plantings. Dwarf and spreading kinds never grow too tall for low houses. Japanese holly *(Ilex crenata convexa)* shown here can be kept in scale with selective pruning. Ground cover is periwinkle *(Vinca minor)*

Molly Adams

THERE are two kinds of evergreen needled and broad-leaved, and be tween them they form an ideal backbon for garden plantings.

The Japanese yews are perhaps th most popular needled evergreens, fo they are a rich dee green in summer an winter, are perfectl hardy, and may be use in many ways on you home grounds. But yo must choose them car fully. You can keep a yews compact by annu trimming of straggl growth, and you ca shear them to form hedge.

Hemlocks are ta

Henry E. Downer

Condensed from *Popular Gardening*, April 1960. Copyright, 1960, by Henry Holt & Co.

Molly Adams

They keep a garden green in winter. Low-growing kinds outside a large window give a year-around view of verdure from indoors. For more distant greenery, spreading junipers can be attractive, with tall conifers planted farther away

Molly Adams

Many grow in poor soil. Junipers and some pines will do well in heavy clay and even sandy soil. They are good on rain-washed embankments. The luxurious juniper depicted here prevents the soil from washing down over a low retaining wall

graceful trees, yet if you set small ones about 2 feet apart and trim them each summer, they make a fine hedge which with care will live for a century or more. There are many forms of hemlock, and one of the most striking is the weeping Sargent hemlock.

Pfitzer juniper has attractive spreading branches, a feathery appearance, and a good gray-green color. You can prune it, but it looks best when allowed to develop naturally, spreading 6 feet or more. For sandy places at the seashore the low-spreading shore juniper is hard to beat.

(*Continued on page* 52)

They make excellent hedges. Whatever one's need, there is an evergreen to fulfill it. Some, like this boxwood planting in Colonial Williamsburg, require little trimming. Pines, hemlocks, and some of the yews need annual shearing

A house is interestingly framed by the spreading pair of crooked trunks on a tree near the edge of the lawn, on which tree shadows are an equally decorative feature. This photograph by Maynard L. Parker is one of a dozen used to illustrate an article by Mr. Parker and Joseph E. Howland in the Summer 1960 issue of *Landscape Architecture*. Entitled "How to Shoot a Garden," it gives some practical lessons in garden photography that, the authors say, "were learned the hard way"

MULTIPLE-STEMMED TREES ADD INTEREST TO THE LANDSCAPE

E. L. Kammerer

Condensed from the *Bulletin of Popular Information*, The Morton Arboretum, Lisle, Illino

SO ACCUSTOMED have we become to having our trees trained to a single stem or trunk that the idea of seeing them grown in any other way seems at first alien and unnatural. The effective ways in which landscape architects have made use of multiple-stemmed specimens has demonstrated their value, however, n only in solving certain landscape pro lems, but also in adding special inter to ornamental plantings.

Especially important is their ability add basal weight to a planting are thereby helping integrate a specim

plant more closely with its surroundings. As a focal point or accent, a tree clump can be used to excellent advantage, too, either by itself underplanted with a ground cover or incorporated into shrubbery groupings. Beside a doorway, at the corner of a building or as the principal subject in a courtyard planting, a tree of this type would be equally appropriate. Modern architecture offers still another opportunity to put multi-trunked trees to good use, that of relieving the monotony of low, uninteresting roof lines.

Aesthetically the architectural framework of a tree grown as a several-stemmed clump is as a rule infinitely more picturesque than a single-trunked specimen, the individual stems in many instances assuming a pleasing irregularity of line. Removal of most of the smaller side branchlets along the lower two thirds of their length in the Japanese manner serves to further emphasize this character. The interesting shadows cast by irregular trunks must not be overlooked, either, whether projected to the ground or onto a wall. And, if by chance decorative bark, distinctive either in color or texture is present, this feature adds further to the plant's desirability.

Old willows along the brook at the Brooklyn Botanic Garden

Leo Pulitzer

SOLUTION FOR A SLOPE

Decorative plantings, sometimes aided by walls, keep the soil from washing away

Carolyn S. Hirsch

Condensed from *The New York Times*, Oct. 2, 1960

Gottscho-Schleisner

To avoid erosion and create attractive planting areas, high stone walls support a terraced lawn, which tapers off to a gradual slope planted with periwinkle and juniper

HILLSIDE PROPERTIES often have many advantages. But too often the banks pose problems for the landscape designer.

Hillside erosion problems can be solved in a variety of ways to achieve appealing landscape effects.

Bare, ugly banks left by grading equipment are quickly eroded by rains. A lawn is not a practical solution because of the difficulty of mowing a slope. Ground cover plants more substantial than grass are preferable. They hold the earth and absorb most of the rainfall.

Gentle slopes and slight changes in ground levels such as a ledge or outcrop

Copyright, 1960, by The New York Times Co., New York, N. Y.

ng rarely require any structural treatent. They can be blended into the propty design. An occasional accent of ants such as cotoneaster, laurel, rhodondron or juniper can be placed strateeally to soften the rocks.

Rock gardens, if tastefully arranged, e decorative and practical slope soluons. Rocks help keep the ground and e plant roots cool, improve drainage, rry water deep into root zones, and duce soil moisture evaporation. The cks should be placed so that they chanl water into, not out of, the garden.

A dry stone wall, made without mortar, another slope solution. It can divide eas of differing heights, define the limits an area, or provide privacy. It can be o to four feet high and requires little oting. It not only holds the soil but, if eps are built through the wall, it can rve as a connection between the two vels. The steps should be of substantial nstruction, with adequate width and an sy ratio of treads to risers.

A dry stone wall can be used as a wall rden. Earth is packed in between the ones as the wall is constructed. In most ses a dry stone wall can run parallel the slope or step down at an angle. few well-placed shrubs can complete the transition from wall to ground at both ends.

In planting a dry wall, it is important to put both soil and plants in place at the same time. Make sure there are no air pockets.

If a garden is desired at the foot of a slope, a section can be cut out of the incline and a small wall set up to retain the rest. If plantings are to be placed above the wall, it can be used to create a level terrace. In either case, space is added to what seemed to be a cramped garden.

A rule of thumb in wall construction is: the fewer small stones used, the more substantial the wall will look. Gradation from large stones at the bottom to thinner stones at the top will assure a solid, safe wall.

Masonry walls, too, have a definite structural function. They can hold back large banks of earth where the ground is so uneven that it is unsuitable to a more natural landscape plan.

Among "wall-top tumbling" plants are Japanese ampelopsis, prairie rose (*Rosa setigera*), weeping forsythia (*F. suspensa*), *Clematis montana* and bittersweet for decorative effect.

HLOROPHYLL IS SYNTHESIZED FOR THE FIRST TIME

The pigment that makes plants green contained in microscopic bodies called loroplasts. There are hundreds of such loroplasts in each single microscopic ll in any green leaf.

The green pigment (called *chlorophyll*) important to all life because it posses the ability of capturing the radiit energy from the sun. This energy is ored in green plants as sugar or starch r more complex substances), from hich man and all other animals, as well plants themselves, derive their existce.

An understanding of the chemistry of lorophyll therefore is of paramount imortance to man. During the past year R. B. Woodward and associates of Harvard University have for the first time synthesized one of the forms of chlorophyll in their laboratory. They have produced *six hundred-thousandths* of an ounce.

This discovery does not mean that man can now make chlorophyll at will, nor does it yet mean an understanding of how nature captures the sun's energy. It is, rather, another great step in the "green stuff" research that was initiated in Zurich in 1904 by Richard Willstaetter. The technical account of the discovery appears in the *Journal of the American Chemical Society*, volume 82, page 3800 (1960).

THE BEST
THAT GARDEN SCIENCE OFFERS

Just because a product is new doesn't mean it deserves a place on your garden shelf. Here are some recommendations

P. P. Pirone

Condensed from *House Beautiful,* January 1961

THE thoughtful gardener is caught on the horns of a dilemma when new garden materials are enthusiastically announced. He knows from experience that many things for which much was promised have failed to deliver. But, on the other hand, we could hardly manage today without the aid of many marvels from the laboratory. Anyone interested in getting better results with less work should know and use the best of the new developments of garden science.

Plant Foods

One of the eternal problems with fertilizers high in nitrogen has been that nitrogen is released faster than the plant can take it up and use it. This can harm the plant, or the plant may reject the excess and it will be leached away and lost.

But scientists have now found a way to combine urea, an organic nitrogen material, with formaldehyde to make a really improved product. The new material, called ureaform, supplies nitrogen to plants safely at an even rate for a longer time than was ever possible before, even with natural organic fertilizers.

Another worthy development in the field of fertilizers is the so-called high-analysis, all-soluble plant food. This comes in a liquid, a paste, or a crystal form. It needs only proper dilution and it is ready to use. The high concentration of the active ingredient makes this material really quick-acting.

If you spray a high-analysis liqu fertilizer on the foliage, the plant begi to use it almost instantly. When t root area is soaked with it, the plant w respond in a matter of hours. It is n meant to be a substitute for a long-ran program of feeding plants, but it c help out in many special situations. will speed growth, improve over-all vig and increase the size and the quality blooms. The high-analysis soluble fer lizers can also be used as a start solution when seeds are sown, or at t roots of plants when you first set th out in the garden.

Weed Killers

There have been a few noxious wee for which science has never develop a really satisfactory control. Japan honeysuckle, poison ivy, and chrysa themum weed are among them.

A significantly more effective we killer for these and most other plants now available. It is amino triazole, non-selective, non-arsenical herbicide. will kill every plant it is applied to— a more positively. Yet with all its streng amino triazole does not persist in t soil. Even if weeds on the ground a sprayed with it, the active material w break down in the soil, and plants can grown safely there in a few weeks.

The chemical works by interfering w the formation of chlorophyll in the leav This process is vital to the life of plants. When it is stopped, the pla

Courtesy of *House Beautiful* Magazine.
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vill die. As the poison starts to work on he plant, you can see the leaves begin o lose their color.

The foliage must be well covered with mino triazole to make it effective. It equires thorough application.

Pest and Disease Control

Sevin is a new and safer type of in-ecticide. It is especially effective against nsects that attack roses, particularly the Japanese beetle. It kills when the insects ouch it or eat it. It has also proved ffective against tent caterpillars and the Mexican bean beetle.

It is non-toxic enough to be approved 'or use on fruit trees and can be applied vithin a day or two before picking. While uch approval is well founded, it is my ersonal practice to wash all fruit and egetables thoroughly before using them. ncreased safety and wider spectrum of ffect are the advantages that set Sevin part. But for all its relative safety, handle it as you would any chemical. Do ot inhale it directly; wash your hands horoughly after use.

Antibiotics, first used for treating uman ills, have found a permanent place n the control of certain plant diseases. One, known chemically as cycloheximide, vill control bacterial blight (fire blight) of apples, pears, hawthorn, mountain ash and other members of the rose family.

A different formulation of the same chemical will control all the more important fungus diseases of lawn grasses. You must be careful to apply cyclohexi-mide properly. If too much is put on, it will turn grass yellow. Too little won't do the job properly.

Phaltan is a new, more versatile fungi-cide. It helps control such diseases as black spot on roses, leaf spots on chrysan-themum and iris, and rust on snapdrag-ons. It is related to captan but has the added advantage of controlling the downy and powdery mildews that captan will not. One shortcoming of phaltan is the white residue it leaves on the plants.

The best and longest-lasting killer of soil-borne insects such as Japanese beetle grubs is dieldrin. When properly ap-plied, it will control insects in the soil for at least five years. Be very careful not to get it on the skin or to inhale the fumes. The easiest, safest way to apply it is in granular form with a fertilizer spreader.*

*Dr. Pirone's original article also de-scribes new chemicals for control of crab-grass, mechanical aids for the gardener, and some new gardening ideas and products that are just emerging from the experi-mental stage.

LIGHT AND DARKNESS IN PLANT BEHAVIOR

The plant pigment called "phytochrome" nay prove to be an important key for the control of germination, growth, flowering, lormancy, and coloring in plants, to the great benefit of agriculture. How this pigment, which is apparently an enzyme, was recently discovered by research men n the United States Department of Agriculture is told in *Light and Plant Development* by W. L. Butler and Robert J. Downs in *Scientific American* for December.

In the 1920's, Drs. W. W. Garner and H. A. Allard of the U. S. D. A. first made t known that many plants bloom only when the days are long (petunias, for example), whereas others (such as chrys-anthemums and poinsettias) flower when the days are short. Now it is discovered that, at least for short-day plants, it is the night hours rather than the daylight periods that affect the flowering. Phyto-chrome is the substance that controls this and many other types of response in plants.

(*Note:* A more technical discussion of this topic is presented by Drs. H. A. Borthwick and S. B. Hendricks, two of the men most responsible for the recent discoveries in this field, in *Science* for Oct. 6, 1960.)

OF MICE AND MEN

Small rodents from the fields damage orchards, nurseries, and gardens when the snow is deep

W. J. Hamilton, Jr.

Condensed from *The Conservationist*, October-November 1960*

AS THE heavy snows of the 1958-59 winter melted away, many a resident of Jefferson County was horrified at the havoc that was exposed. Ornamental trees, hedges and shrubs were stripped of their bark; valued roses and flowering plants were cut to the ground or completely girdled; bulbs were eaten. This great toll was exacted by hordes of field mice whose chisel-like teeth spared little vegetation.

Under a protective layer of vegetation, these small rodents prepare compact nests of dried grass. Radiating from these nests, little trails, the width of a garden hose, form an intricate pattern of highways, revealed only when the snow disappears in late winter.

No other mammal can match the reproductive rate of the field mouse. In years of mouse abundance, one litter follows another in rapid succession, until it seems the meadows and fields will boil over with the little rodents.

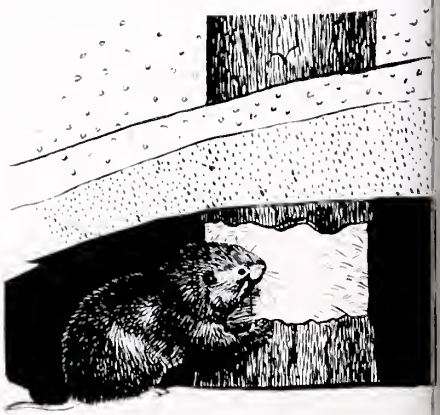
Orchardists have borne the brunt of the great economic loss caused by field mice. Snow cover is a deterrent to the hunting activities of mouse predators, and, under cover of a white mantle, the mice have free rein to move about in areas they would otherwise shun. Bark is stripped from the base of the trees, and the life line of cambium destroyed. Beneath the soil these little rodents and their sleek-furred cousins, the pine mice, cut away the slender roots, weakening the tree and making it susceptible to heavy winds and winter storms. I believe New York orchardists may sustain a half million dollar loss in "mouse years."

While the orchardist may suffer most severely, those who propagate conifers for sale often suffer considerable loss. Scotc pine, Douglas fir, Norway spruce ar other cone-bearers are all susceptible girdling by field mice.

In the perennial border, the ravages field mice often attract the attention the gardener. They have invaded my li plantings, and, under cover of a sawdu mulch, laid waste the bulbs of prize seedlings. Few plants are immune attack.

Control can be accomplished by t use of poisons, traps and wire guar that may prevent girdling activitie These methods are discussed in Corn Extension Bulletin 729 available at yo county agricultural agent's or upon r quest to College of Agriculture, Corn University, Ithaca. In the home garde field mice are easily controlled by ord nary snap-back mouse traps, but, to effective, at least a dozen should be use

Man's efforts to combat these mi are only of local and temporary effe Perhaps it is fortunate. Field mice little or no harm unless they conflict occasion with man's interests.



*Published by the New York State Conservation Department, Albany, N. Y.

FAREWELL TO CRABGRASS

New chemicals keep crabgrass out of the lawn permanently by killing the seedlings

William H. Daniel

Reprinted from *American Home*, March 1960

MATERIALS that can *prevent* crabgrass are just as near as your garden-supply dealer. One application any time before crabgrass gets started, and the pest is out of your good grasses for the season. All you have to do is spread toxic concentrations of the proper materials uniformly over your lawn, and crabgrass seedlings will be killed soon after they germinate. Established grasses (those already growing) won't be seriously affected, so only the crabgrass will be selectively prevented. This is known as pre-emergent treatment. The other and more familiar way to control crabgrass is to kill the plants after they have grown by applying chemicals to the foliage. This post-emergent method currently requires a minimum of two applications, usually made in midsummer—when your lawn may be almost pure crabgrass!

Facts About Crabgrass That Will Help You Fight It

Crabgrass starts from seed each year, grows mightily through summer, produces and drops seed, and is killed by frost. It thrives in heat and sunshine, and doesn't grow well in the shade of trees or of dense high-cut (2-inch) lawn grass. It looks fairly attractive in hot midsummer, but is not a good lawn grass! It dies and rots, leaving bare ground through winter and all of spring. Each plant produces thousands of seeds. Unfortunately, these seeds can remain alive in the ground for years before sprouting. The ones on the surface, where sun can reach them, begin to germinate in spring with the first warm wet period, when temperatures reach 75°. That's about the time iris blooms. And they keep coming up all summer! There can be as many as 50 seedlings germinating in one square inch of soil! The ground in your yard is undoubtedly full of crabgrass seeds; so is any topsoil you might purchase. But one place crabgrass seeds do *not* come from is lawn-grass seed that you buy! It's tested and accurately labeled as to content.

How Crabgrass Preventers Work

The principle of getting rid of crabgrass with pre-emergent treatment is to kill it before it passes through the seedling stage. Chemicals must be in place in the soil just at the surface before seeds germinate. This means putting them on in early spring, or getting a head start in fall or winter, so all is ready before lilacs bloom. In Southern California it should be on by February, or in Chicago by May 1. Then as crabgrass seeds sprout, their young roots absorb so much chemical that the plants die by the time they reach the "two-leaf stage." Of course, if any seedlings escape death, either because the chemical missed the soil where they were, or because it wasn't applied at a strong enough rate, they may grow extra big and troublesome. So it's extremely important to spread the chemical uniformly over every inch of ground and at adequate rates. Light rates are a waste of time and money. This is particularly true of chlordane formulations.

After application, avoid digging weeds, or otherwise disturbing the surface of the soil, or you may bring up additional crabgrass seeds.

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Some other pesty annual lawn weeds and weed grasses are also controlled in seedling stage by preventer chemicals. These include foxtail and barnyard grass, common and mouse-eared chickweed, and annual bluegrass. Full-grown plants of chickweed and annual bluegrass are killed by arsenicals too.

As a marvelous bonus, the crabgrass preventers kill grubs and insects in the soil. This indirectly keeps moles out of your lawn, since they feed on soil pests.

A Word of Caution

Observe common-sense rules and precautions when storing and using crabgrass preventives. Follow the instructions on the package just as you would for any other garden chemical. Research men and product distributors have found no evidence of harm to pets and children.

SOME PRE-EMERGENT CRABGRASS KILLERS

Product Trade Name	Rate per 1000 sq. ft.
Arsenicals	
Pax	20-25 lbs.
Pre-Kill	18 lbs.
No-Crab	18 lbs.
Chip-Cal Granular	12 lbs.
Di-met P.C.C.	12 lbs.
Stopps	12 lbs.
Crabgrass Seed Killer	25 lbs.
Calcium Arsenate, granular	12-20 lbs.
Calcium Arsenate, powder	10-12 lbs.
Lead Arsenate, powder	20-24 lbs.
Non-arsenicals	
Halts	10-16 lbs.
Green Velvet	15 lbs.
Chlordane 10% granular	15 lbs.
Chlordane 72% liquid	2 pts.
Rid	10 lbs.
Zytron	See label
DAC 893	See label

How to Apply Chemicals

You'll find directions for spreading an amounts to use on the bags in whic chemicals are purchased. Follow thes instructions carefully. Use a lawn spread er. If you don't own one, you can usuall rent one from your garden-supply dealer The setting that's about right for mos kinds gives measured openings of 3/16 t 1/4 inch.

• *Uniform application is a must.* Avoi skips, or your lawn may have strips wher crabgrass comes through.

Timing the Treatment

• *General rule:* Don't put crabgrass pre venters on unless you have a lawn estab lished.

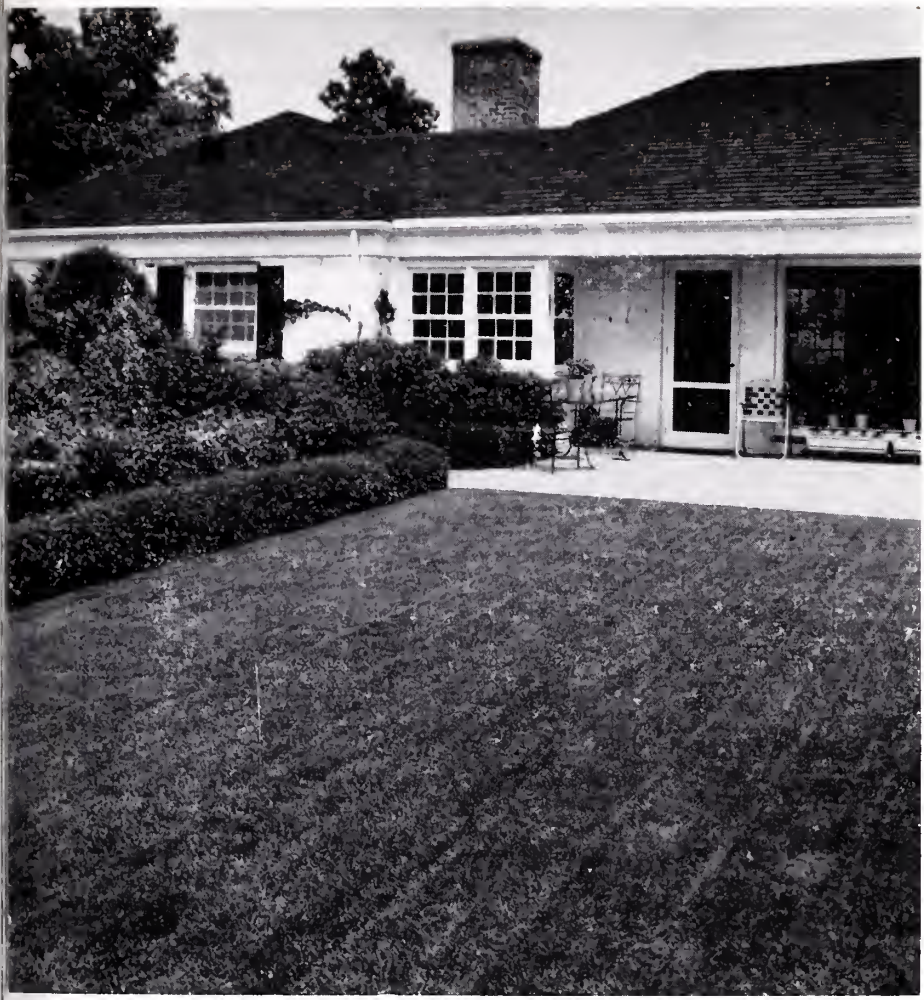
• *On old lawns:* Apply either autumn o very early spring. If grass is so heavil infested with crabgrass that considerabl reseeding will be necessary, the first ste in renovation might be killing crabgras this summer with post-emergent chemi cals. Follow this with fall reseeding an feeding. Then next spring apply pre venters.

• *If you started a new lawn from see last fall:* You can treat it early thi spring. Lawn grasses should be bi enough to have been mowed twice; thei larger size and deeper roots increase thei resistance.

• *If you're sowing seed for a new law this spring:* Hold off treatment unt autumn or early next spring. In th meantime, kill the crabgrass during th summer with two applications of post emergent chemicals such as AMA c DSMA (such as Sodar, Di-met, Orth Crabgrass Killer, etc.) applied to foliag

• *If you start a lawn from seed early th fall:* It can be treated late this sam autumn, but it's safer and better to wa until early next spring.

• *If you want to reseed big bare spots* It's best to get grass well started befor treating for crabgrass prevention, just a with a new lawn.



Noer & Wilson

A well-tended lawn is a property's mark of distinction

• *To maintain toxicity:* Repeat treatment every 2 or 3 years (fall preferred) at recommended rate for new treatment. Or each year apply ¼ to ⅓ of normal rate.

What's the Cost?

Preventing crabgrass is not cheap. Chemical production, transportation, and distribution are expensive. Several products retail at near $5 per 1000 sq. ft. to get toxicity and control the first year, then about $2 per 1000 sq. ft. to maintain toxicity each year.

Follow-Up Procedure

Getting rid of crabgrass doesn't insure a dense green lawn. Something has to fill the gaps left where crabgrass grew! Overseeding may sometimes be the obvious answer. But usually it's smarter to feed what grass you have (if it's merely thin, or full of small bare spots). For when the competition of vigorous crabgrass is removed, the desirable grasses can quickly expand into the space, if they have the help of food. Plan to give your grass two or more applications of lawn

fertilizer every year—in the spring and again in late summer or early fall.

If you're treating with arsenicals, better control is expected if you use the new lawn fertilizers, many of which are high in nitrogen and low in phosphorus. High concentrations of phosphorus reduce arsenic's effectiveness; with low phosphorus availability, less arsenic is required. You may prefer to use nitrogen fertilizers only, the first year or more, since grass responds most to nitrogen. Some of the pre-emergent products have nitrogen in them as a service to users.

The time that must elapse after using crabgrass preventers, before grass seed can be planted, varies with different chemical products. Chlordane, Zytron, and DAC prevent nearly all seedlings for a month or longer. Arsenic will slow and weaken seedlings, though bentgrass and bluegrass species tolerate arsenicals more than crabgrass.

WEED GRASSES IN LAWNS*

R. Milton Carleton

A SERIOUS threat to quality lawns during 1961 is the existence of large stocks of contaminated foreign seeds of various lawn grasses. Unfortunately, these are not contaminated in the legal sense of the word, since impurities are largely *Poa annua* and various species of bent grasses. All these wild grasses are used for lawn purposes in both Europe and the United States, hence do not fall under the classification of noxious weeds.

As a result, they need not be named on the label except as "other crop," a term which tells the average home owner nothing. *Poa annua* and bent grasses are all disfiguring when grown in a turf of fine fescues or bluegrasses and are particularly bad in a Merion bluegrass lawn.

Any contamination of seed with *Poa annua* should condemn a mixture. Even as little as 1% means at least 10 plants to the square foot at the rate bluegrass seed is sown.

Poa annua, once considered a desirable lawn grass, may appear on an analysis tag as "annual bluegrass," deceiving the inexperienced lawn maker into believing it is a desirable lawn bluegrass. It is a "winter annual," sprouting in the fall after exposure to temperatures below 42 degrees. This means that it germinates when there is little or no competition from permanent lawn grasses. By spring, it has made such vigorous growth that permanent grasses are crowded out. It produces seed in early summer, and usually dies soon after leaving large bare areas where crabgrass can get a start. The best way to fight *Poa annua* is to exclude it from the lawn.

Another serious threat to lawns is the appearance of Kentucky 31 fescue in turf mixtures. It is used because of the selling power of the name Kentucky.

Kentucky 31 fescue is *not* a fine-leaved species, but is one of the tall fescues. It is so coarse that it is often mistaken for quack grass. Along with Alta fescue (from which it can scarcely be distinguished) it can be used for coarse, rough turf where heavy wear is a problem, as on playgrounds, or where nothing else will grow, as on Long Island's sand. It has no place in a home lawn with any pretense of beauty. If it must be used in heavy traffic areas, it should never be mixed, since the combination with other grasss permits the tall fescue to form coarse clumps. Once in a permanent lawn, it is impossible to control it chemically without destroying all other grasses.

*Condensed from information released by Vaughan's Garden Research Center, Chicago Illinois, Summer 1960.

'PLENTY OF ROOM ON TOP!'

A bus conductor's cry suggests columnar trees to avoid crowding in a small garden

Will Ingwersen

Condensed from *Gardeners Chronicle* (London), Nov. 5, 1960

THE MORNING had been a rather harassing one. No small town garden could possibly contain all the trees and shrubs I had been asked to find places for.

As I boarded my bus, already full to capacity on the lower deck, the conductor cheerily cried, "Plenty of room on top!" Something clicked, and I had an answer to the problem which had eluded me all morning. The only part of a small garden which provides limitless space is upward, and there must be plenty of fastigiate (slender, upright) trees and shrubs.

In a really small garden a spreading bush of rosemary might well become an embarrassment, but the same sweet aromatic fragrance and a similarly pleasant evergreen appearance are available in *Rosmarinus officinalis* 'Miss Jessup's Upright,' which grows in the form of a slender-waisted, dark green bush, as columnar as an Irish yew.

A large, double pink flowering cherry can be quite overpowering in a small garden. *Prunus* 'Amanogawa,' on the other hand, is a fastigiate cherry, making a pillar of stiff erect branches and becoming a gentle candle-flame of apple-blossom pink in the spring.

The common yew presents us with a splendid narrow column in the form of *Taxus baccata columnaris*. This is particularly useful where space is seriously limited as it is very slow growing and unlikely to attain much more than 4 or 5 ft. in a great many years.

A curious and striking hawthorn, *Crataegus monogyna stricta*, fashions a tall, spear-like stem feathered with short, upright branches into a statuesque silhouette, which it adorns with white flowers in the spring and red haws in the late summer and autumn. There are two erect forms of the hornbeam, *Carpinus betulus columnaris* and *C. b. pyramidalis*. The former is the slenderer of the two.

I know of no tree with more grace than the silver birch and it would seem that a fastigiate variety must, of necessity, sacrifice much of the elegance in the delicate tracery of the arching branches. Nevertheless, *Betula pendula fastigiata* has contrived to combine, in the waved lines of its long, erect branches, all the symmetry and beauty of the familiar tree.

Even on the smallest rock garden *Juniperus communis compressa* is not out of place, and its neat, dark green candle-flames provide an invaluable sense of proportion to a miniature landscape. It adds no more than ¼ in. to its stature each year and a very, very aged specimen is unlikely to be more than 2 ft. in height. *J. c. fastigiata*, a taller plant but of similar shape, is of immense value for creating or accentuating a salient point in the garden—a feature of all fastigiate trees and shrubs which should by no means be forgotten.

Chamaecyparis lawsoniana wisseli may, in time, attain a height of 15 or 20 ft. and yet be no more than 2 ft. in diameter at its thickest point. It is dark green in colour, and a foil to its sombre tint can be achieved by planting *C. l. fletcheri*, whose leaves are silver-grey.

Where either *C. l. wisseli* or *C. l. fletcheri* are considered too tall, their place may well be taken by *C. l. ellwoodi*. It is very slender, dark green, and although in time may reach 10 ft., it will take many years to do so. A taller, more quickly growing column of bright, fresh green is provided by the 'Kilmacurraugh' form of *C. lawsoniana* and for richness of colour it would be hard to beat *C. obtusa tetragona aurea* in its winter dress of rich bronzed gold.

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ROLLED-UP CUTTINGS

Mary Noble

Condensed from *The New York Times*, Oct. 30, 1960

CUTTINGS ARE prepared in the usual manner, in lengths of six to eight inches, just as they would be prepared for rooting in pots or flats. A rooting hormone may be applied to the cut ends if desired. Once the cuttings are ready, the packaging procedure is simple. Cut a strip of clear plastic eight inches wide and thirty inches long from a dry-cleaner's bag or similar source. Spread it out flat.

Cover one-half of the strip, along its full length, with a quarter-inch-thick layer of damp builder's sand. Lay the cuttings like railroad ties on the bed of sand. The bottom ends should be set in about a half-inch or so from the edge of the sand, with their tops protruding beyond the sand and plastic.

Space hardwood cuttings about an inch apart. By allowing space at each end, there will be about two dozen cuttings on a thirty-inch strip. (In the case of soft-wood cuttings with foliage, wider spacing on the roll may be desirable.)

Fold the clear bottom half of the plast up over the sand and the ends of tl cuttings. Gently roll up the packag from one end to the other. Secure tl roll with two or three rubber bands in a neat and sturdy package.

Stand the bundle in a box containi other rolls and place the box in a col frame. Single bundles can stand in flower-pot. Cuttings cannot wobble such a package as they do in a box loose sand. The plastic keeps the sa damp longer, yet the tops of the cuttin are exposed to light and air so foliag can develop next spring.

Judge the storage temperature accor ing to the hardiness of the plants involv and the season of the year. If bottom he is desirable for hardwood evergreen cu ting, individual packaging in this ma ner permits separation of those plan which have different temperature requir ments. Of course, all rolls should labeled.

Copyright, 1960, The New York Times Co., New York, N .Y.

Lou Egne

Half of the width of a strip of plastic is folded over cuttings which have been placed on bed of damp sand

Lou Egner

Tied firmly in a roll, each package of cuttings can be placed under the proper conditions for rooting

Unroll some packages in each location about once every two weeks to test the moisture. If the sand seems dry in the spot-checked rolls, pour a little water into all of the bundles through the top edges of the plastic. It is not necessary to unroll them.

Rooting progress may be noted by simply unrolling the bundle; this eliminates the tugging of cuttings which is the usual test for root development in pots or flats. It is time to remove the cuttings when examination shows that they have roots more than one-half inch but less than about one inch in length.

Unroll the package and lay back the plastic covering. Each cutting can be lifted out individually without damage to its new roots or those of its neighbors. Any unrooted cuttings can be rolled up in the sand again for additional rooting time. Treat the rooted cuttings according to custom, which may mean individual potting or setting out in prepared nursery rows next spring.

Note: This convenient, space-saving method of rolling cuttings in a sheet of plastic has been used with peat-moss or sphagnum (instead of sand) for the past two years at the Brooklyn Botanic Garden.

POISONOUS PLANTS AROUND THE HOME

Two dozen ornamental plants of Florida, most of which are also well known to northern gardeners, are poisonous either to touch or to taste, declares Erdman West. In "Poisonous Plants Around the Home," Bulletin 175 of the Agricultural Extension Service, Gainesville, Florida, he describes these plants and tells in what ways they are poisonous. Each species is clearly illustrated by Esther Coogle.

Among the ornamentals treated are allamanda (in the north, a greenhouse vine), castor-bean, rosary pea, crape-jasmine, crown-of-thorns, dieffenbachia, the gloriosa lily, Carolina-jessamine, jimsonweed, angel's trumpet, larkspur, oleander, poinsettia, pokeweed, and primrose (*Primula obconica*).

Flower-Pot Experiments

Comparison of plant growth in clay and plastic pots has revealed that growth is generally better in plastic pots, particularly if the pots' drainage is improved. Some results of experiments made in England are reported in the *Gardeners Chronicle* for November 5, 1960. Transparent plastic gave better root development on some of the plants tested.

Horticultural Nomenclature

V. T. Stoutemyer

Condensed from *Lasca Leaves**, Summer 1960

ONE OF the great needs of the modern world is for universal systems of communication which transcend national barriers. The musicians have long had a uniform world-wide system of notation and you could easily have a symphony orchestra with men from a hundred different nations. The symbols of the mathematician are likewise universally understood. Botanical descriptions of plants have been published in Latin from the time of the founding of modern plant taxonomy and this convention has been followed by botanists of all nations.

The rules for botanical names are found in the current International Code of Botanical Nomenclature. These rules were originally formalized about a century ago and have been revised at intervals by the various international botanical congresses. Since horticulturists necessarily give names to plants which would be lumped together by the botanists, they have a supplementary set of rules. These can be found in the International Code of Nomenclature for Cultivated Plants which was issued in 1958. A copy of this document can be purchased from the Arnold Arboretum, Jamaica Plain 30, Mass.

The term "variety" as used by botanists and horticulturists unfortunately has entirely different meanings. In order to avoid this confusion, horticulturists are now rapidly adopting the substituted term "cultivar," which is a coined word derived from the term "cultivated variety." The term "cultivar" has a very broad area of reference and it includes (1) line-bred selections which come relatively true from seed, such as are most varieties of garden flowers grown from seed; (2) vegetatively propagated clones; and (3) line-hybrids, which are plants with uniform characteristics produced a will by the crossing of selected paren maintained for the purpose. Doubtless th word "cultivar" will come into commo horticultural use just as the earlie invented word "clone" is now standar but there is no compulsion to adopt it.

The new code for cultivated plants wa prepared by several cooperating intern tional groups of horticulturists, foreste and other agriculturists. It has alread been approved by the last Internation Horticultural Congress at Nice, Fran in 1958 and presumably will have the of eial approval of the other sponsoring o ganizations in due time. We think that th present outlook for stability and uniform ity in both botanical and horticultur nomenclature is very good indeed. W believe that these two codes represent sane and constructive approach to a dif cult problem.

At the present time, nine organizatio have the official approval of the last I ternational Horticultural Congress as ce ters of registration for cultivar names their particular specialized plant group We may expect to see the list grow rapi ly and we hope that there will be a tre toward a more truly international a perhaps more comprehensive type organization for doing this necessa work.

Personally, we regard the proposals use the next edition of Hortus as a sour of plant names and to use the Bail Hortorium as the clearing house for e specialized plant group organizations s logical and wise at the present time. f we are not to be bound by a dead han we must have a living, working center f authority. Most botanists and botani institutions tend to ignore the taxonomic problems of cultivated plants and th are few if any other institutions wh would have facilities for the job.

*Published by the Southern California Horticultural Institute and the California Arboretum Foundation for the Los Angeles State and County Arboretum, Arcadia, Calif.

New Plant Hardiness Map

Henry T. Skinner

Condensed from *The American Horticultural Magazine*, October 1960

THE *New Plant Hardiness Map* which has been sponsored by the American Horticultural Society came off the press in late May.

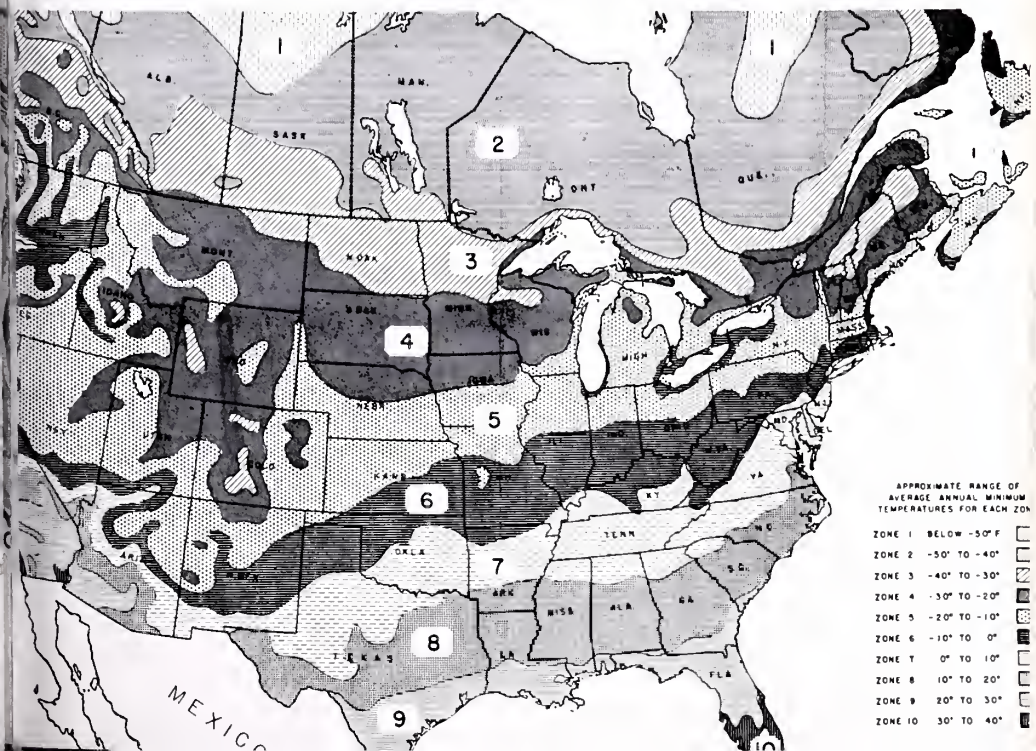
This new uncopyrighted 19 by 28 inch color map shows ten minimum temperature plant hardiness zones for the United States and southern Canada (exclusive of Alaska and Hawaii) in an up-to-date and more detailed pattern than in any previous studies of its particular kind.

The coldest zone shown on the map is in parts of Canada where winter temperatures average lower than fifty degrees Fahrenheit below zero, while the warmest zone of thirty to forty degrees cuts across the southern tip of Florida, the southern tip of Texas, parts of southern California and the San Francisco area.

The single sheet reverse carries use and descriptive information, examples of six persistent plants typical of each zone, and zone classifications for a hundred and twenty-five or so woody or persistent plants, as well as a simplified black and white version of the color map for small-scale reproduction in books, nursery catalogs, etc.

Minimum winter temperatures have served as a basis for the excellent Rehder and Wyman maps of the Arnold Arboretum and this new version differs from the widely used Arnold map only in the incorporation of greater detail, in minor modification of the zone intervals and in use of additional more recently available weather data, horticulturally reprocessed and scrutinized.

Ed.—This map, depicting zones of hardiness for plants, is available for 15 cents from the Superintendent of Documents, Washington 25, D. C. It was prepared by a committee of which Henry T. Skinner, Director of the U. S. National Arboretum, was chairman.



RAISING WILD ALPINE PLANTS IN A HOME GARDEN

A Japanese naturalist speaks from two generations of experience

Tomoya Funahashi

Drawings by Eva Melady from Funahashi originals

WHEN you climb high mountains you may be attracted by the pretty and noble alpine flowers that decorate the rocky fields. You may stand there for a while to admire them and you may wish to have them in your garden. You may bend forward to the flowers. But wait! Don't pick them! If you bring them down to your garden without knowing how to raise them, they will die in a couple of weeks.

When I was a junior high school boy, I was attracted by the noble beauty of the alpine flora, and ever since then it has been my hobby to raise these mountain plants. Here I should like to explain how I keep them growing in my garden.

The most important matter is to understand their environment and nature. Then what is their environment?

1. *Air and light.* In their native places, they are growing in windy spots under sunlight that contains much ultraviole radiation.

2. *Soil.* The earth on which they ar growing is a mixture of fragments o rocks and dead leaves. While these dea leaves may be broken up, they neve decay; the temperature is too low to le decomposing bacteria grow. The soi contains a large amount of air and i always wet, but the water runs dow through the soil; in other words, the soi is well drained.

3. *Weather.* It is very changeable; fo only a few hours each day can the plant enjoy sunlight. For only four or fiv months are they not covered with snow During the rest of the year they remai under deep snow where, according to m understanding, the temperature stay constantly at just about freezing. Thu the roots of these plants are neve damaged by alternate freezing and thaw ing.

Dr. Tomoya Funahashi, a Japanese eye specialist, is presently in the United States on a Research Fellowship. He is in the Department of Ophthalmology of Long Island College Hospital and the State University of New York, Brooklyn, New York.

Dr. Funahashi started his hobby as a schoolboy, having learned the methods from his father. He continued it at his home in Nagoya until he left for Tokyo to go to Medical School. While in Medical School and during the war, he had neither time nor opportunity for his hobby but resumed it upon his return to his home near Nagoya after the war, and continued it until he came to America in 1960. His 11-year-old daughter, Yukari, is looking after his collection while he is away from home.

Alpine plants in their containers in Dr. Funahashi's garden. At the right a rock set in water is temporarily wrapped in nylon sheeting, as shown in drawing on page 34

From these facts of environment we can see the nature of alpine plants and better understand their requirements.

1. They want to be exposed directly to morning sunlight, but to have light shade from afternoon sun.
2. They like a windy place.
3. They do not like hot weather; especially are their roots sensitive to heat.
4. Their roots are very weak in soil with decomposing leaves.
5. Their roots require plenty of air and water, but they do not like stagnant water.
6. Their roots are easily damaged when the soil is repeatedly frozen and melted.
7. Six months after their new spring growth has sprouted they need to have winter sleep, and some of them stick to this habit even in lowlands.
8. Most of them extend their roots horizontally rather than vertically.

Of course there are some exceptions.

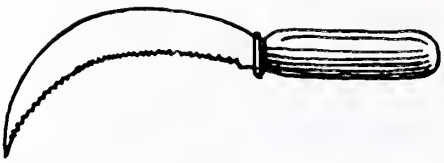
The secret of being sucessful in raising alpine plants is to create circumstances very similar to their native places and not to go against their nature. My method is as follows:

1. *To choose a pot.* I plant them in

In large cities in Japan there are enough people (mostly in middle life or elderly) interested in the hobby of growing mountain wild flowers that they have organized clubs called "Sansokai." This word, exactly translated, means "mountain grasses club." Three times a year we have exhibitions.

We distinguish mountain flowers as those that grow in the lower mountains—up to one mile in elevation. Those that grow above this elevation (above tree line) we call alpine plants. Alpine flowers are more beautiful than mountain flowers because there is more bloom in proportion to the amount of foliage. Then, too, alpine flowers are more difficult to grow in "captivity," and therefore offer the greater challenge.

There are also local carnation, cactus, and orchid clubs in Japanese cities, besides national organizations of persons interested in growing chrysanthemums and roses.—T. F.



Small saw-tooth sickle for cutting the tough network of roots and soil around plants being collected

flower pots. Usually I use shallow and flat ones because these allow the plants to extend their roots horizontally so that they get plenty of air. But there are some, described below, which like deep and large pots.

2. *Soil.* I use sand which is mixed with gravel or pebbles. I screen out the tiny particles of sand with a sieve. Then the sand is heated in a large, hot, iron pan to sterilize it. If you do not like to do it in such a complicated way, you can dry the sand a few days under the heat of the sun, before mixing it again with the gravel. I store the soil mixture in a large wooden box, ready for use.

3. *Gathering plants.* When you go to gather plants, please bring your vasculum (a large metal container slung from one shoulder by a strap) and a tiny saw-toothed sickle. The sickle is very convenient for cutting the soil around the roots of plants. (I have not seen such a sickle in America, but it is more satisfactory than a trowel and I heartily recommend it.) Dig up the plants you want with as much soil as you can and keep them in the closed vasculum.

4. *Planting.* Take the plants from the vasculum, cut off flowers, flower-buds and seeds, dip and wash their roots in water in a bucket. When the soil around the roots is completely removed, wash them again in clear water, take out from the bucket and press the roots between gauze to remove the water.

Now you will find tiny, somewhat decayed pieces of leaves entwined by hair roots; remove these carefully with forceps, wash the roots softly this time, and take water out from the roots again with gauze. If you find the roots are too short for the plant, cut off a few branche and leaves with scissors.

Cover the center hole of the bottom o the pot with a chip of slate or fragmen of cracked pot, then hold the plants i the center of the pot and pour the pre pared soil mixture into the pot.

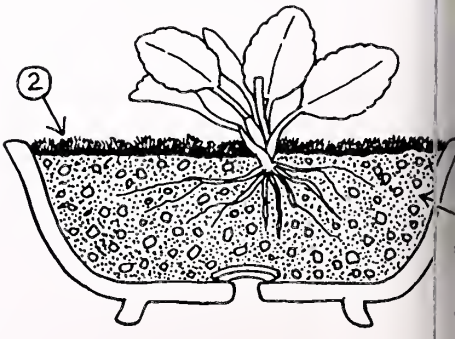
Gather mosses that grow in your gar den, enough to cover the surface of th soil in the pot. Wash mosses and tak off the soil and dead leaves as much a possible. Then spread these mosses ove the surface of the sand. Water the plant

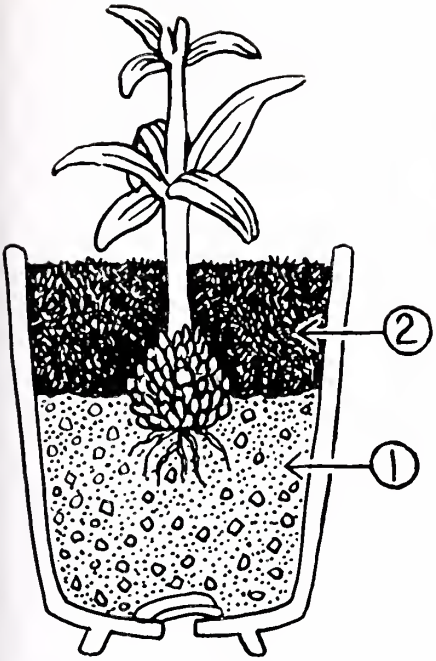
I should like to explain the reason fo such a procedure. The soil of mountain may be said to be a mass of fragment of leaves. If we do not take these o the roots, the decomposing or putrefyin bacteria that grow in the warm soil a lower altitudes will decay the roots o plants just as they themselves decompos

The sand mixed with pebbles holds large amount of air and the water passe through it very quickly, but the san holds enough moisture to keep the root alive. The mosses covering the san protect the sand from being warmed u by the sunlight and also prevent th sand from drying out.

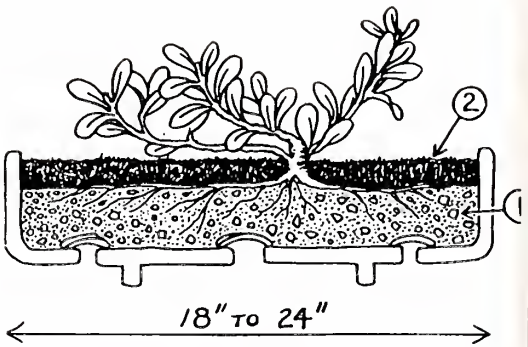
Most of the Japanese alpine flora ca be cultivated with this method. Th

Sectional view through shallow pot, to sho how most of the Japanese alpine specie can be grown in culture. Soil mixture pebbles (gravel) and sand (1), showin position of plant *(Lagotis glauca)*, wit moss growing on surface of soil (2). P should be unglazed (inside, at least), an drainage hole covered with broken crock plastic screening





Fritillaria growing in culture. Sectional view through a deep pot; bonsai containers are good for this purpose. Sand and pebble mixture (1), with fritillaria bulb planted as indicated. Sphagnum moss (2) fills upper portion of pot



Rhododendron aureum growing in culture. Sectional view through large flat oval (or rectangular) container. A bonsai container 18 to 24 inches long and 3 inches deep is about right. From 1½ to 2 inches of sand and pebble mixture (1), in bottom of container. Rhododendron planted on top of sand, then covered with about 1 inch of sphagnum

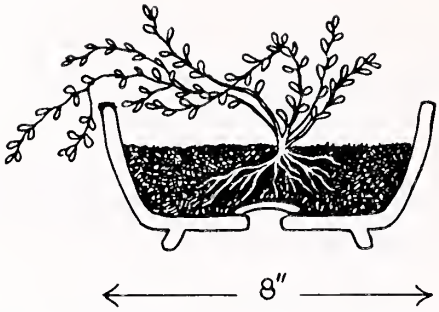
species I am now keeping in my garden in this way are listed below.

Some species of alpine plants need special culture. I should like to explain these.

Dicentra peregrina, a miniature purple-flowered bleeding-heart. We must prepare a deep and big pot for them.

Alpines Grown in Sand and Pebble Mixture

Andromeda polifolia	Bog-rosemary
Anemone narcissiflora	Anemone
Aquilegia flabellata	A yellow-flowered columbine
Campanula dasyantha, C. lasiocarpa	Bellflowers
Chrysanthemum yezoense	A northern Japanese daisy
Dianthus shinanensis	Pink
Gentiana algida, G. nipponica	Gentians
Geum pentapetalum	Avens
Lagotis glauca	Of the snapdragon family
Leontopodium fauriei	Edelweiss
Minuartia verna	Sandwort
Patrinia triloba	A Japanese valerian
Phyllodoce nipponica	A heath-like shrub
Potentilla nivea, P. matsumarae	Cinquefoils
Primula cuneifolia	Primrose
Saxifraga merki, S. cherlerioides	Saxifrages
Stellaria rusciflora	Starwort
Vaccinium vitis-idaea	Mountain cranberry



Vaccinium oxycoccos in pure sphagnum moss. Sectional view through flat container, showing position of plant growing in 3 to 4 inches of sphagnum

Plant them only with gravel and do not cover the surface of the gravel with mosses.

Fritillaria camtschatcensis, a far northern fritillary. We prepare a deep pot. Fill half of it with sand and gravel and bury one-half of the bulb in sand. Then fill the rest of the pot with sphagnum moss.

Rhododendron aureum (*R. xanthostephanum*), which has bright yellow flowers. I prepare a large flat pot, filling it with coarse sand and gravel. I cover only fine roots with sand and put on sphagum moss to cover big roots and surface of sand. (Other dwarf rhododendrons might also be grown by this method.)

Vaccinium oxycoccos (also known as *Oxycoccus quadripetalus*). This cranberry-like plant is very easy to cultivate; you use only sphagnum, and it does not require the elaborate washing of the roots.

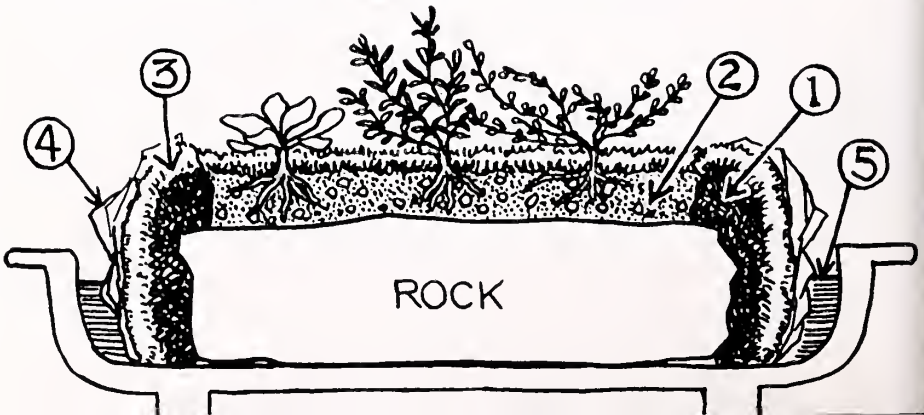
There is another method for planting alpine plants. This is to use a tiny rock or stone. You can find fragments of rocks in the streams or on the roads when you go to mountains or hills. Choose a flat one and bring it home. Gather mosses from your garden and wash away the soil and dead leaves attached to them. I dip dried sphagnum moss in water and squeeze it, then I press it against the sides of the rock; being moist it adheres to the rock, covering it completely. Next I cover the surface of the sphagnum with garden mosses. These I cover with a nylon sheet, tied with a string, to prevent the mosses from falling down from the sides of the rock.

Around the edge of the upper surface of the rock I make a dike (1 to 1½ inches high) with wet sphagnum moss. Next I cover the outer side of the dike with garden mosses, then with a nylon sheet, and tie these to the rock with a string.

I fill the hollow made with the dike around the upper surface of the rock with sand and gravel mixture. The alpine plants are set in the sand-gravel mixture, the surface of which is covered with mosses. The rock is placed in a shallow basin and the basin is kept filled with water. After one month the nylon cover may be taken off. By then the garden mosses will have covered the side of the rock and prevented the sand and sphagnum from falling away from it.

This method is very suitable for most of the alpine flora except *Dicentra peregrina* and *Fritillaria camtschatcensis.* I

Diagram (sectional view) for method of growing alpines on a rock. After a "dike" (1) has been built around the rock with sphagnum moss, a mixture of sand and pebbles (2) is placed about 1 inch deep within the enclosure. Garden mosses (3) are then planted on the sphagnum, and nylon sheeting (4) is tied around the garden mosses with string. The container should be water tight (no drain hole), and water (5) should always be at a visible level around the rock



used to plant several different species on the same rock.

5. *Where to keep these pots and basins.* I constructed a wooden table (3 feet high) in my garden where I could expect direct sunlight during morning and enough ventilation all day long. I put my plants on this table. It is preferable not to have them exposed to the sun in the afternoon. They do best in afternoon shade.

6. *How to take care of the plants.*

(a) Watering: Usually I water them once a day early in the morning but during summer I do so again in the evening. This time I give them water by dipping the pots. This cools the roots of the plants.

(b) To protect plants from the afternoon sun: During summer I protect them from the heat of the sun with a marsh reed screen. This allows narrow sunbeams to pass through the spaces between reeds and to reach to the plants. This amount of sun does not warm the soil of the pots too much and is enough for the health of the plants.

(c) To protect plants from cold: In contrast to the constant above-freezing winter temperature beneath the alpine snow, on the level land at lower altitudes the temperature in winter always goes up and down. The earth alternates between freezing and thawing nearly every day. This hurts the delicate roots of alpine plants. So I keep the pots and basins in a coldframe, where it is just above freezing all day.

If you cannot find a suitable place to keep your alpine plants in winter, you can dig a hole 2 to 3 feet deep in your garden, put in the pots and the basin with rocks in it and cover them with dried dead leaves. But if you keep them in a hole, in February and March you must be watchful to see when they wake up from their winter sleep. As soon as you find a tiny bud on plants in the pots or on your rocks you must take them out from the hole and place them on the table in the garden.

(d) To protect plants from insects and worms: A spray of DDT (prepared for garden use) once in two weeks is enough.

7. *Fertilizing.* I use the rapeseed meal that is left after the making of rapeseed oil. I mix a small handful of rapeseed meal in a quart of water and keep it in a pot or jug. When the meal decomposes, it smells very bad, so a cork may be put in the jug. After two or three months the water in the jug will not smell any more. Then it is ready to be used as fertilizer.

I dilute the fertilizer ten times with plain water and pour a small amount of it at the most remote spot from the plants in the pots. To give fertilizer once in a year seems enough for alpine plants.

I do not give my plants fertilizer during summer, but only in early spring as soon as I find their tiny buds coming out.

8. *Plants difficult to raise.* The alpine species I name below are very difficult to raise at home, but I have managed to grow some of them for as much as two years. They are:

Cassiope lycopodioides
: A low, flowering evergreen

Cypripedium yatabeanum
: Lady-slipper orchid

Diapensia lapponica
: Diapensia (very difficult; only two months)

Dryas octopetala var. *asiatica*
: Asiatic wood-nymph (one year only)

Glaucidium palmatum
: Similar to May-apple

Pinguicula vulgaris var. *macroceras*
: Butterwort

Before I finish my writing, I should like to ask you not to dig out more than one plant of the same species from any one place. This is very important if we are to prevent the species of alpine flora from perishing.

It is fairly popular in Japan to raise alpine plants, so there are gardeners in Hokkaido, the most northern island of Japan, who are cultivating these plants in their gardens and sending them to department stores in large cities in the fall. Thus we can buy them, wrapped with sphagnum moss, and we do not devastate the mountains.

Eva Melady

ROADSIDE WILDFLOWERS IN UNSPOILED ALASKA

Louise Potter

IT was on June 16, a bright crisp morning, that we left Paxson Lodge to make the crossing of mid-Alaska via the newly opened Denali Highway. This leads from the Richardson Highway, one of Alaska's oldest trails, across to Mount McKinley National Park, which was never accessible to road travelers until the Denali was built.

The trip was an adventure, not only because the road was a new one which had almost no human being living along its 160-mile stretch, but also because we hoped we should find some unspoiled, "unlooted" wildflower country.* The route took us mainly above timber line with continuous views of snow-capped mountains, glaciers, great eskers, and wild rivers. I am writing here an informal record of what flowers grow close enough to this new road for the motor traveler to enjoy.

In the immediate Paxson area, close to the lodge, Summit Lake still had ice, but the sun was hot and in June there is light nearly all night; hence there were many flowers in bloom despite disturbance to the area from the recent building of the road and of the lodge itself. In the thin spruce woods there were the persistent and familiar friends of lower Alaskan elevations, such as the fireweed relative, *Epilobium latifolium,* with its striking large magenta flowers and gray-green leaves—often mistakenly called "glacier lily"; *Geranium erianthum,* much the same wild geranium (crane's-bill) that I knew in Michigan and New England; spikes of the arrow-leaved sweet coltsfoot (*Petasites sagittatus*), with its large triangular leaves; plants of creeping crowberry (*Empetrum nigrum*); the bog bilberry (*Vaccinium uliginosum*) with light pink bells; the attractive pinnate-leaved and yellow pea-blossomed weed, *Oxytropis campestris,* sometimes called loco-weed; and *Betula nana,* a handsome dwarf birch shrub with tiny, round, shining leaves.

In a little less than ten miles, we came upon a glorious upland tundra meadow, above timber line, blue with lupine (*Lupinus arcticus*), a veritable sea of it, but that was not all! Here I saw my first Lapland rosebay (*Rhododendron lapponicum*) with lovely deep red blooms. This was new to me although I live within 50 miles of Mt. Washington where I know it grows. (We found it later, of course,

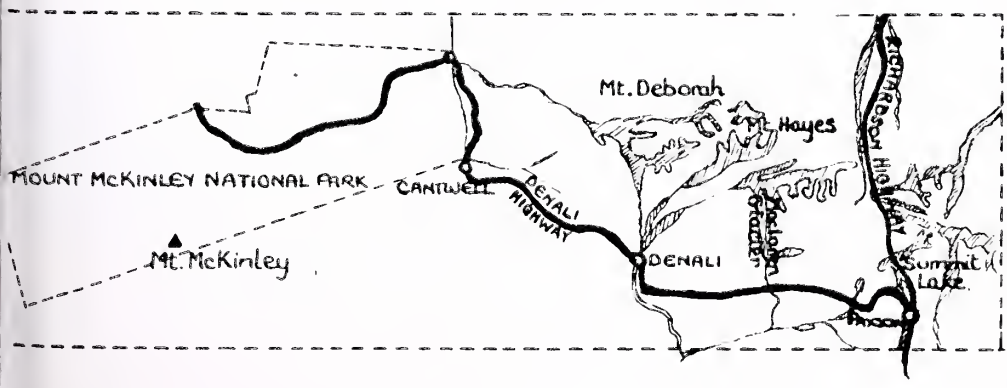
*For further reference to Alaska's wild flowers, see the "Flora of Alaska" by J. P. Anderson, 543 pages, 1,074 drawings, published in 1959 by the Iowa State College Press, Ames, Iowa, at $8.50.

Maps by Elizabeth Scholtz

growing in McKinley Park.) Another "first" here was the very fragrant, low-growing rock-jasmine (*Androsace chamaejasme*), both pink and white. This was indeed a flower garden with not only the blue of lupine, the magenta of *Epilobium latifolium,* but also the delicate pink of the wallflower or single stock *(Parrya nudicaulis),* pink spikes of bistort *(Polygonum bistorta),* the deep yellow of *Anemone richardsoni* and the Arctic poppy *(Papaver radicatum),* and the snowy whites of the anemones *A. narcissiflora* and *A. parviflora,* and also of the two wood-nymphs, *Dryas octopetala* and *D. drummondi.*

Shrubby plants, aside from the dwarf birch, the bog bilberry, and the rhododendron, included the tiny Arctic willow *(Salix reticulata),* which has an attractive rounded leaf, red stems, and one large "pussy"; also a dwarfed Labrador tea (*Ledum palustre decumbens*).

At least two of the ferny-leaved louseworts, so common in Alaska's uplands, grew here: *Pedicularis parviflora* and *P. lantana,* both pink-flowered. The brilliant blue of chiming bells, the Alaska bluebell (*Mertensia paniculata*), was just beginning to show; the only other true blue was that of a tiny corydalis, a baby "bleeding heart" *(Corydalis pauciflora),*



some specimens of which here had pink flowers.

Here also were various of the saxifrages, found later on in the park: *Saxifraga lyalli,* with red stems; creamy-yellow *S. caespitosa,* a tufted plant; and the taller reddish-green *S. hieracifolia,* as well as a saxifrage "cousin"—*Leptarrhena pyrolifolia* — called pear-leaf. There were cushions of that familiar yet always attractive, pink-flowered ground cover called moss pink or moss campion (*Silene acaulis*). Among the persistent weedy plants I should perhaps list two with pea-like blossoms: *Astragalus umbellatus* with creamy-yellow flowers and *Oxytropis campestris* with oyster-white flowers.

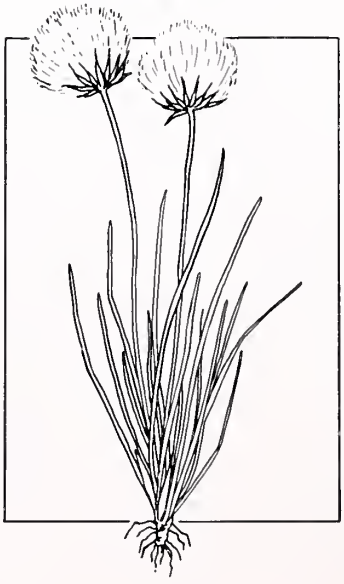
Plants which might almost be missed among the taller offerings because they were either tiny or delicate were *Oxytropis nigrescens,* with its pure purple pea-like blossom seeming much too large for the rest of the plant, mats of *Diapensia lapponica* with golden centers; *Claytonia scammaniana,* pink with very slender stems, like a New England "spring beauty"; and the whites of chickweed (*Cerastium beeringianum*) and of the long-stalked starwort *(Stellaria longipes).*

After the excitement of the beauty of the meadow and the discoveries near Mile 9, it was difficult to pull away, yet there was still a long and unknown 150 miles of gravel road ahead—and of course, as it proved, there were other gardens almost as rewarding as this first one. In wet roadside ditches as we went along was tan, cluster-headed Arctic cotton-grass, *Eriophorum angustifolium,* I think, though I am not a specialist on the sedges.

Curiosity was kept within bounds until about Mile 35, near the 4,086-foot McLaren summit, where it seemed evident we might be missing new flowers. Perhaps it was the tall, lavender-blossomed Jacob's ladder (*Polemonium acutifolium*) that caught our eye. Here we found most of our friends of Miles 9–10, the lupine, silene, and bistort; in addition there were stalks of lovely pink bells on the wintergreen *(Pyrola asarifolia),* growing with the blue corydalis; a new pedicularis, the purplish pink *P. sudetica;* an attractive small senecio, or groundsel, *S. resedifolius,* with deep yellow heads; another astragalus, *A. alpinus,* its white blossoms edged with purple; and two Arctic cottons, the tan one and the small,

Bog bilberry
(Vaccinium uliginosum)

Arctic cotton-grass
(Eriophorum callitrix)



Wood-nymph
(Dryas drummondi)

Eva Lady

single, white plumes of *Eriophorum scheuchzeri.*

After this there was a stretch of road mainly of geologic interest, with eskers, and land barren of almost all vegetation but grasses and sedges until after we crossed the McLaren River. At Mile 60 where the Clearwater River crossed there is a dry, flat place on which to park the car, with access to the river for hand-washing and a good place to eat a picnic lunch. While there are no trees, there is a tiny flower garden to explore by a brook. Though this is very high country, almost half the flowers found were ones familiar in Alaska at much lower elevations. For instance, we found the shooting star, *Dodecatheon frigidum,* which carpets the Eklutna Flats at sea level with pink-magenta in the first week of June. Others were the blue *Mertensia paniculata,* the bright yellow *Anemone richardsoni,* the fragrant white Kamchatka rock cress, *Arabis lyrata,* and the wormwood, *Artemisia tilesi,* whose tall, weedy spikes one finds growing on sandy roadsides almost at sea level in the Kenai.

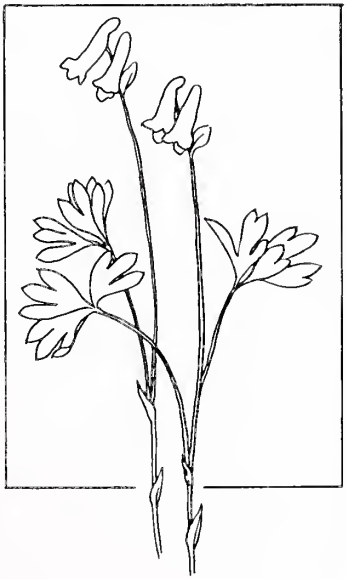
Woody plants here were mainly the dwarf willow *(Salix reticulata)* and the shrubby cinquefoil *(Potentilla fruticosa),* beloved of all Alaskans as their "tundra rose." This has scattered butter-yellow flowers and very attractive cut-leaved foliage. I am surprised that northern New Englanders do not also prize this cinquefoil.

Here I found the first violets of the day *(Viola adunca,* lavender with long-stemmed leaves) tucked under larger plants along with the tender-stemmed corydalis. Two other cinquefoils, non-shrubby species, appeared here: *Potentilla norvegica* and *P. rubricaulis.* For the first time on this road I saw the tall, white, fragrant wild heliotrope *(Valeriana capitata)* growing with the deep purple-blue clusters of *Polemonium pulcherrimum.* Other "firsts" for this stop were the deep-red-topped king's crown *(Sedum rosea)* and the waxy white bells of the mosslike, decumbent mountain-heather (*Cassiope tetragona*).

Soon after the Clearwater River stop, still going west, we began to come down into the drainage of the Susitna River with a first view to the north of the three great peaks of Mounts Hayes, Hess, and Deborah, each over 12,000 feet, and of the McLaren Glacier which feeds the Susitna River. Twenty-five miles or so

Lapland rosebay
(Rhododendron lapponicum)

Corydalis
(Corydalis pauciflora)



Diapensia
(Diapensia lapponica)

after we crossed that river we came into light spruce woodlands. We made two other stops at Miles 117-118 and at about Mile 124-125. This terrain offered many more shrubby plants, for instance: a white-flowered dwarf spirea *(Spiraea beauvardiana)* very much like our taller, cultivated one; a wild red currant *(Ribes triste),* with panicles of rusty blossoms; a woody, creeping bearberry *(Arctostaphylos alpina)*, with greenish-white bells and very attractive oddly-veined oval leaves, and the bog-rosemary *(Andromeda polifolia).* This is a slender-stemmed shrub with very few leaves and with nodding bell-like flowers of bright pink. All these were in addition to others seen earlier: *Betula nana, Cassiope tetragona, Empetrum nigrum, Ledum palustre,* and *Vaccinium uliginosum.*

Though there were fewer herbaceous plants and tufted clumps of flowers here than at the greater elevations, still we found *Mertensia paniculata, Epilobium latifolium, Anemone richardsoni, Pyrola acutifolia,* and *Dryas octopetala* (the last two slightly woody though small). Along a sandy river bank were the tall, lush-growing knotweed (*Polygonum alpinum*), known to Alaskans as wild rhubarb, and carpets of a yellow daisy, *Arnica alpina.*

As we came to the end of our new road, where it approaches the long-settled community of Cantwell, on the Alaska Railroad, we began to find dandelions (*Taraxacum vagans),* shepherd's purse *(Capsella bursa-pastoris)* and others which seem to follow the tracks and abodes of men. It was with great reluctance that we left behind us the meadows of flowers which thrive only in an undisturbed and virgin land.

ACTION NEEDED TO PRESERVE AMERICA'S ROADSIDE BEAUTY

The time is now, when routes for federal-aid highways are being laid out by state engineers

Richard H. Pough

Condensed from the *Bulletin of The Garden Club of America,* March 1960

IN years to come the image of America will be strongly influenced by the character of the countryside adjacent to the new federal-aid highways. A few acres of beautiful landscape so located will be more significant than thousands elsewhere. Over the centuries to come, millions of eyes will rest with pleasure on every scrap of natural beauty that we can preserve along these highways.

The best time to preserve such areas is when highway rights of way are being acquired. Fortunately, the Federal-aid Highways Act encourages such acquisition by providing that up to 3 per cent of the federal subsidy to the states may be used for this purpose. If this provision is to produce the result that Congress intended, highways planners and engineers need to have called to their attention areas of "natural beauty" suitable for preservation under the provisions of this section.

Garden clubs and other civic groups can, therefore, make a very real contribution to the success of the whole fed-

eral-aid highway program by lending a helping hand. One way is to point out specific opportunities along the route through their community, once the highway planners have selected it. Another would be to appoint a committee that could work with the State Highway Department and go over routes while they are still in the planning stage.

Prompt action, however, is of vital importance. The federal-aid highway system is being built, and the time to acquire these areas is when the land for rights of way are being bought. Remember, the beauty of what in the future will be the most conspicuous segment of America is at stake.

One Successful Fight

When Glen Helen, a 1,000-acre preserve of great natural beauty, deeded to Antioch College, Yellow Springs, Ohio, was threatened with a 300-foot dual limited-access highway in 1958, a vigorous appeal was made through many media, but chiefly through an arresting booklet, "Witnesses to Wilderness," prepared by Kenneth W. Hunt, Director of Glen Helen. The fight was a stiff one; but the friends of Glen Helen finally won, and the area was spared from the invasion of traffic. The booklet is an excellent example of an effective publication in the interest of preservation of natural beauty.

OUR COUNTRY'S LANDSCAPE—ITS BEAUTY AND DIVERSITY

Reprinted from "The Vanishing Natural Areas of the United States: A Program for Their Preservation"*

F. R. Fosberg

NATURE attracts and satisfies man in many ways and for many reasons, in accordance with each individual's constitution and background. Most easily understood of these reasons is nature's unfailing beauty. Man's response to the feel, smell, and sound of nature, his sense of order, and his need for relaxation, all are powerful motives. The naturalist and scientist are pulled by their insatiable need to know. But a factor that represents one of the deepest needs of the human emotional make-up is the craving for variety. Of all the punishments that man can inflict on himself, monotony is, in the long run, the most deadening. And monotony does not exist in nature.

The endless diversity of natural habitats and the living things that compose them are a constant source of delight when one leaves the areas that have been remade by man. As one travels in the still wild parts of America he need never be bored if his eyes are open and his senses alert. Let us take brief stock of this diversity, considering what it was, noting what is happening to it now, and trying to foresee its future.

The virgin mosaic of biotic communities that carpeted the North American continent before the arrival of man was undoubtedly a reflection of the equally complex mosaic of rocks, soils, and water, slopes, ridges, and valleys. These were

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American Museum of Natural Histor

"Landscape patterns of an awesome immensity and starkness, plants fantastic in shape and adaptation."—A scene in Saguaro National Monument, near Tucson, Arizona, as depicted in a diorama at the American Museum of Natural History in New York

modified in broad strokes by the continental climatic pattern, and showed strongly the effects of the continent's complicated physiographic and climatic history. Vast areas were covered by trees of many kinds and in endless mixtures. The center of the continent was a sea of rich tall grass, becoming lower and sparser westward. In the west and southwest were large stretches of desert, where a less favored environment created landscape patterns of an awesome immensity and starkness, plants fantastic in shape and adaptation, and animals with strang and wonderful habits.

Seasonal climatic variations and fluc tuations in animal populations cause short-period cyclic changes. Successiona change, however, occasioned by the ic age, mountain building, and erosion cy cles, though characteristic of all nature was in those times slow.

Ten thousand, or perhaps several time that many, years of occupation by mostl sparse populations of early invader from Asia brought about alterations i

this pattern, some of them drastic, others subtle and hard to read. Perhaps the diversity in the natural pattern was augmented by these aboriginal Amerieans. Very likely they brought with them a few, though not many, new animals and plants. More rapid change, called by ecologists *secondary succession,* was introdueed into the picture as nature's healing proeesses went to work on man-made sears.

Then European man burst upon this seene with an energy, and a ferocity, never before seen in the history of the world. Attaeking from three sides, fighting and destroying indiseriminately the aboriginal human inhabitants, animals, trees, and grass, he changed the face of the continent in three short centuries far more profoundly than had all the Pleistoeene ice sheets. From a condition of relatively stable vegetation with more aetive changes locally, the situation has been reversed, until stable vegetation is now a highly prized rarity. Most of the continent is, instead, a vast mosaic of secondary successions and the controlled pioneer habitats that we call cultivated fields.

Most of the original biotic eommunities, with all their pleasant diversity, are vanishing before our eyes. A certain amount of new diversity has, indeed, been added. Gully erosion, seab rock, hedgerows, stone walls, and patehes of strange assemblages of weeds and cultivated plants from all continents have become the common sights. The inexperienced naturalist sometimes does not even know that these are extraneous features.

Mueh of what we now see seems more confusion than diversity. The aeeurate reflection of the physical environment by the biotie communities is obscured and becomes impossible to read and fully understand. Change is so rapid that it occurs even while studies are being made. In large parts of America anything resembling the original exists only in tiny patches that have accidentally escaped, reliets that tell us—though only a little—about what was here originally. It is these, more than anything else, that The Nature Conservaney is seeking to save. Only by preservation of these sparse remains will future generations be able to know what Ameriea was like originally and enjoy at least a little of the wonderful variety that man found when he came.

The Best Way to "Keep" Land is to Give It Away

Here and there aeross the eountry one still finds an oeeasional area in private or elub ownership on whieh the native plant-animal community remains virtually undisturbed. Generally its eontinued existence is due to the owner's appreeiation of its uniqueness and a long-standing policy of complete protection.

Such relies have great value to seience as reservoirs of strains and races of plants and animals adapted to the loeal soils and climate. It is, therefore, important that some non-profit nature preservation organization work out with the owners of such traets plans for their permanent preservation.

In the long run the best way to "keep" a large block of wild land that proteets the privaey of a club or family holding is to give all but the residential property to a suitable non-profit eustodian. This should be done with a deed containing a reverter elause that sets up a second non-profit organization as a watehdog to make sure that the terms of the gift are strietly adhered to. The tax benefits ineidental to the process may practically make it a ease of "eating your eake and having it too."—Riehard H. Pough.

DISCOVERY OF THE DOUGLAS FIR

An author's "adventures" with some of America's early explorers lead to some thoughts on our disappearing wilderness

Condensed from a chapter of "Wilderness" to be published in March by Dodd, Mead & Company, New York.

Rutherford Platt

ONE day in April 1825 a three-masted brig, the *William and Ann,* was warped into McLoughlin's dock at Fort Vancouver (opposite Portland, Oregon). She hailed from England, had rounded Cape Horn and been more than eight months at sea. She had just crossed the treacherous sand bar at the mouth of the Columbia after lying to for six weeks, not daring to approach the California coast in "gales a thousand times worse than around Cape Horn."

Down the gangplank came an excited young man—David Douglas of the Horticultural Society of London. Eight months of sea had bronzed his face and hardened him for the wilderness, but the clothes that he had just changed into were fresh out of a London shop. He wore spectacles on his nose; he lighted his pipe with a magnifying glass, using the sun's rays, and he enjoyed "an effervescent drink" (whiskey and soda perhaps?). When McLoughlin caught sight of this young man, he strode through the crowd and gave him an especially hearty welcome.

Until David Douglas arrived they saw forests, not trees, in the west coast wilderness. The forests were tall and dark; they contained fur-bearing animals and savages; they supplied logs for forts and cabins. But nobody noticed what kind of trees they were or anything special about them. One of the greatest trees in the world which had its homeland on the northwest coast had not been recognized.

As the *William and Ann* sailed up the Columbia River, David Douglas was overwhelmed with the wilderness, unbelievably different from anything he had seen in England. "The scenery is grand . . . lofty hills well wooded with pines . . . mountains covered with perpetual snow." He was so fascinated by the dark forests which he saw from the ship's deck that he could hardly wait to plunge into them. Mr. McLoughlin cautioned him and gave him a woodsman's outfit with gun and knife, taught him how to treat Indians and grizzlies and how to use streams and animal trails to keep from getting lost. In the months that followed Douglas merged with the wilderness. Even when he wandered through shady stillness among tall straight trunks, he called the trees pines. He measured a fallen one —227 feet long and 48 feet in circumference. He considered them "the most striking and truly graceful objects in nature," but they frustrated him. He wanted to collect fresh cones with ripe seeds that grow near the tops of the trees. "I couldn't climb to get the cones. Buckshot didn't reach them. The trees are too large to cut down with a hatchet."

In the long run, of course, David Douglas got what he was after. When

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the Horticultural Society of London examined the cones and seeds, the buds and needles which he brought back, they recognized that a new kind of tree had been discovered, unlike all other evergreen trees. They gave it a complicated scientific name which means "false hemlock with yew leaves." We call it Douglas fir, and it is the most valuable forest tree on earth. The strength of its streaming grain is revealed by its use as tall masts and spars. The weight of the northwest wind leaning against a mainsail may make a ten-inch boom bend like a bow. But Douglas fir holds with the strength of the primeval wilderness.

* * *

It was thanks to people like these that I discovered how big this continent of ours is. It is wide enough to contain within one land mountains as massive as the Rockies, Sierras, and Appalachians; deep enough to contain forests as vast as the Eastern Green, North Black, and Northwest Giant; plus five lakes that look like five oceans; rivers as mighty as the Mississippi, St. Lawrence, MacKenzie, and Colorado; a prairie like the High Plains as a pasture for sixty million monster bison; deserts as immense as the Mohave, Sonora, and Great Basin where unearthly animals and plants live —and there was always another wilderness beyond!

Emerging now from these adventures I find myself in the vicinity of Fifth Avenue and Forty-second Street in New York, pushed around by a crowd that is hurrying somewhere. They have just voted themselves out of the last piece of unspoiled wilderness in the northeast, in the Adirondacks in New York State. They seem to want to cut it in two with a fast throughway, which will scare the animals and birds to death with pitilessly strident sounds, awful fumes, destroy the runways and trails, and change the water table that keeps the wilderness alive. I wonder why they didn't send that highway around. And I wonder why they are draining so many wet lands where heron must stand and ducks and geese feed. Is there no other spot for a lot o' little houses?

I wonder where the heath hens that danced on Martha's Vineyard have gone, and the magnificent great auks which dove for fish from the rocks along the Maine coast, and the beautiful passenger pigeons with the irideseent feathers, and the majestie ivory-billed woodpeckers who owned the cypress swamps, and the eagles floating over the Hudson River.

Somehow I can't get out of my mind and heart the pathetie loneliness of the handful of whooping cranes who use their five-foot windpipes like French horns to bugle *kerloo, lerlee-oo*, and the little key deer, and the proud old condor who, as this is written, is still floating in the winds over California, and the few buffaloes left over from those thundering herds, and the funny little prairie dogs. Do these lonely ones know that their ancestors lived in cities with multimillion populations where the antelope played?

I have seen in Hawaii bulldozers scooping up in a single afternoon tropical wilderness of great age and splendor. Can't they build their hotel in any other spot? In the northwest I have heard the scream of power saws in three minutes run through the heart of a giant tree that had taken five hundred years to create. Can't they grow enough wood in the tree farms? They are planning to lay wide strips of sterile, gray concrete along the last untouched dunes of our land on Fire Island off the south shore of Long Island. Why isn't it better to continue to go there in boats to enjoy the swaying dune grasses and the wild shore birds?

I find myself holding a few fragments of a living wilderness that was the depth of our being and the wealth of our land —and these are slipping through my fingers.

WATERSHED: CONSERVATION KEY

And a Watershed Association of local citizens can get Federal aid to promote conservation within the area of a river and its branches

Mrs. Charles Woodman

Reprinted from the *Bulletin of The Garden Club of America*, January 1960

WHAT is a Watershed? A watershed is the area through which a river and its tributaries flow.

A Watershed Association is made up of the people living within the watershed. It is a non-profit, non-political corporation. A watershed, itself, can be thousands of square miles, such as the Potomac or Delaware River watersheds, or it can be the runoff from your roof and grounds. But whichever it is, that water is going somewhere. How it gets there, what it does to other people's property en route and what condition it is in when it reaches its ultimate destination are major conservation problems of our times. It is also your problem whether you live in a suburb or on a farm.

The purpose of the Association is to arouse interest in local conservation problems and to translate this interest into action. An association, on a watershed basis, establishes common ground for unifying all conservation activities. People with diverse interests, agricultural, industrial, and residential, can get together with a common goal. Because the watershed area crosses man-made lines of towns, counties, and sometimes states, it also crosses political boundaries, thereby avoiding local controversies.

Once the Association is incorporated, there are various agencies available for advice, such as the Soil Conservation Service and American Forestry Association, to name just two. They are all concerned with portions of the conservation picture, but without a Watershed Association to work through, they cannot treat the problems of the area as one related unit. Here is a basic starting point for unifying their efforts.

Since the Association is an organization of the people themselves, its financial support is derived solely from membership dues and contributions.

There is need in this country for groups of private citizens to investigate, study, and inform others as to just how good our public policies are in terms of effective conservation and long-range planning. Land and water use must be based on nature's laws as well as upon man's economic drives.

In 1954 Public Law 556 was passed by Congress, which is a tremendous boon to Watershed Associations because under this Act an association may receive technical and financial help from the Federal Government in undertaking works of improvement regarding soil and water. Under this Act, a project is a local undertaking with federal help, not a federal undertaking with local help.

We all face extreme problems with increasing urban development. But there is a right way and a wrong way. Not all the open areas have to go, nor do we have to lose all our best top soil as the transition goes on.

Dr. Paul Sears writes, "What kind of a Nation do we want? Do we wish to build a future completely and ruthlessly mechanized, standardized and artificial?" Citizens must not acquiesce to studies made by professional planners. They must seize the initiative. Their boldness and vision will determine how well their community grows. I would urge you to consider the Watershed Association approach as the most efficient means of furthering all phases of conservation.

CLIMATRON OPENED AT MISSOURI BOTANICAL GARDEN

THE world's first giant-dome greenhouse having no interior support was opened at the Missouri Botanical Garden in St. Louis last October. Christened the "Climatron," it is also the world's first fully climate-controlled display conservatory. The idea for it was conceived by the Garden's new director, Frits W. Went, as the first phase of the institution's second-century plan for redevelopment.

Seventy feet high and 175 feet in diameter, the glasshouse covers more than three-fourths of an acre. Dome weight is carried to the ground on five piers; there is no other supporting structure. The dome is made of aluminum tubing in hexagonal patterns, lined by a layer of quarter-inch Plexiglass, suspended just below the under side of the framework. Lights are reflected against the dome, giving a shadowless interior.

Two air-conditioning systems make it possible, without dividing walls, to provide different climates in different sections of the conservatory. A lowland jungle, for example, is in one section, a dry tropical area in another, and in a third a "little Hawaii" for plants requiring cool days and warm nights. Aquatic plants, including the giant "Victoria regia" waterlily (*Victoria amazonica*), bloom in a pool which has an underwater viewing tunnel.

Construction was made possible by contributions. An admission charge of 50 cents (except to children) goes toward maintenance. An illustrated brochure describing the Climatron is available from the Missouri Botanical Garden for 25 cents.

SPRINGTIME IN THE FOREST

Photographs on this and the facing page are from an article by John W. Andresen in Natural History magazine, April 1960.

John W. Andresen

OPENING OF A HORSE-CHESTNUT BUD

Dramatic changes take place as the bud of a horse-chestnut opens in spring. The waxy, sticky bud that was formed last year begins to expand *(left above)*, and the outer bud scales loosen and separate *(right above)*. Embryonic leaves and flower clusters come into view as spring advances *(left)*. Contents of the bud are enclosed in protective cottony hairs

Photographs by Harold V. Green

ıs the bud scales curve way, the miniature flower luster and the leaves are eady to expand (*right*)

FLOWERS OF OAK

'atkins of male flowers of lack oak are formed in the ıme bud with leaves

RADIATION: AN AID IN PLANT IMPROVEMENT

Seymour Shapiro

Condensed from *The Garden Journal*, September-October 1960*

THE GOAL of plant breeding is to produce varieties of plants that are capable of performing certain functions in a more efficient manner than do varieties currently in existence. Among the factors that contribute to natural variation, hybridization and spontaneous mutation rank high.

Mutation, defined as a structural alteration in the hereditary material (the genes) located within the nucleus of the cell, occurs suddenly and unpredictably.

The first indication that one could experimentally increase the mutation rate came in the late 1920's from the researches of Drs. H. J. Muller and L. J. Stadler, working independently. They discovered that by exposing their material to X radiation there was a substantial increase in the frequency with which certain obvious characteristics were changed to a different form.

How does radiation produce a mutation? What does it do to the cells of the plant to produce such a fundamental change? The determiners of development, called *genes,* are organized on and constitute a part of certain discrete structures, called *chromosomes,* which are within the nucleus of every cell of all plants and animals. In order then to change the pattern of inheritance, one must alter these genes or their arrangement on the chromosomes. Radiation, whether it be light, heat, X rays, neutrons generated in an atomic reactor, or the alpha, beta, or gamma radiation emitted by radioisotopes, is a form of energy, and energy is capable of performing work. With the exception of ligh and heat, all the radiations just mentione are called *ionizing radiations* becaus they produce, either directly or indirectl charged atoms called *ions* as they pa through matter. When energy, in th form of ionizing radiation, is beame through tissue, some of it will strike th chromosomes of the nucleus of one c more of the cells. In traversing the chr mosomes some of the energy is absorbe and this may result in a structural chang in the molecules of which the chrom somes and genes are constituted. Th genes may express themselves differentl and new characteristics become appare in the plant.

The greater part of this newly creat variability will be deleterious and sterili runs high in such material. Most of th resulting plants will be discarded by th plant breeder. However, if one has sp cific objectives of improvement in mi and can employ accurate and efficie means of screening large populations as to reveal the presence of the ra individuals that carry the desired trai then the sacrifice of large numbers plants is of no great consequence. Su traits as improved flower color, increas or reduced plant height, changes flowering or fruit-ripening time can directly observed if they appear in t irradiated population. More subtle ch acters, such as disease resistance a drought or temperature tolerance, a not immediately obvious except as response to a particular stress, and t scientist must use natural or artificia created stress conditions if he is interest

*Published by The New York Botanical Garden, Bronx Park, New York 58, N. Y.

in locating individuals with these characteristics in an irradiated population or in the progeny of an irradiated population.

Only a few seeds or a few buds first display the mutation. For this reason, the new type will generally appear as one branch, all or part of which is distinctly different from the remainder of the plant. From this initial appearance of the "sport," one must propagate a large enough population to permit a critical evaluation of the new type.

What are the accomplishments of the radiation approach thus far? At Rutgers University Prof. L. F. Hough and his associates have been studying the effects of radiation on peach trees. Sports for both earlier- and later-ripening fruit have been found as single branches, or parts of branches, on trees of the varieties 'Fairhaven' and 'Elberta' that had previously been irradiated in the Brookhaven gamma radiation field. A late-ripening 'Elberta' sport seems particularly promising commercially. Some of the peach mutations have also resulted in firmer fruit flesh and changed fruit texture. In the variety 'Brackett' a sport was discovered from the normal freestone to the clingstone pit condition. Horticulturists at other institutions have reported fruit color changes in apples and pears, a larger-fruited muscadine, and disease-resistant currants.

In floriculture, Prof. G. A. L. Mehlquist of the University of Connecticut has selected several improved carnations from his radiation experiments, and these are now being evaluated under commercial growing conditions to determine their over-all suitability for release as new varieties. These selections include changes in color, flower form, and increased vigor of the plants. Flower color changes, largely because of the ease with which they can be detected, have been found in a large variety of species, among them being the African violet, cyclamen, phlox, snapdragon, tulip, rose, chrysanthemum, geranium, and petunia.

Since work was started earlier with agronomic plants than with horticultural ones, one can expect, and one finds, that the status of research with agronomic species has progressed further.

Radiation-induced characteristics at this stage in development include dwarf forms of rice, sorghum and barley with little or no accompanying loss of yield (but which render the plants less susceptible to wind damage); stiffer straw and altered grain-ripening time in a variety of small grains; disease resistance in wheat, oats, flax, peanuts, barley, and bluegrass; and increased yield in several different species. When one considers the relative infancy of research in this field, the long period required for testing selected mutations and sports, and the large number of still unanswered theoretical questions, the answers to which will undoubtedly increase the efficiency with which radiation is used, the results at this point seem highly encouraging.

World-Wide Trends in Orchid Culture

Amateurs deserve the credit for much of today's extensive culture and hybridization of orchids, reports Mary Noble in *Flower Grower* for August 1960. Writing upon her return from the Third World Orchid Conference, which took place last May in London, she remarks that commercial growers who formerly aimed for bigger and better blooms for the cut-flower market now are obliged to satisfy the hobbyists' demands for more interesting, generally smaller, plants for home culture. Miniature orchids from Japan are increasing in popularity.

(*Note:* The *Proceedings of the Third World Orchid Conference,* a book of 442 pages with 10 color plates and 24 pages in black-and-white illustration, appeared late in 1960. The Royal Horticultural Society, Vincent Square, London, S.W. 1, England, is the publisher; U. S. price, $6.)

(*Continued from page* 13)

Mugo pine is a compact rounded species that will not overpower a small garden. You can use it to mark a doorway or path, for it exceeds 3 feet only when very old.

Rhododendrons head the list of broad-leaved evergreens with their colorful flowers and deep green leaves. They like well-drained humus-filled soil and a mulch to keep their roots cool and moist.

Mountain laurel, with white or pale pink spring flowers, has about the same needs as rhododendrons. Nursery-grown plants are more shapely and easier to establish than collected ones.

Japanese andromeda has lustrous dark green leaves, tinted copper as they unfold, and drooping clusters of cream-white spring flowers.

Holly has taken the country by storm, and many new varieties are finding their way into gardens. They all like sun, but will thrive in part shade. Include at least one male tree in a planting to in sure berries on the female ones.

Box is useful for edging paths, for doorway accent, and also as a hedge. Yo needn't be afraid to shear it.

Don't overlook barberries when you ar shopping for evergreens.

Nandina or heavenly bamboo is relate to barberry and is popular in souther plantings. It has compound leaves tinte red in the spring and again in the fal and its small white flowers in long clu ters are followed by showy red berrie

Among the many euonymus there ar both bushy shrubs and clinging vines. new group of Emerald varieties are v value for foundation plantings, and th are satisfactory for low hedges.

Camellias are outstanding for the war sections. In selecting varieties remem ber that the sasanqua varieties flower i fall and the japonicas in the spring.

Warning Against "Operators" Whose Sensational Advertising Misleads and Cheats the Plant Buyer

The Federal Trade Commission plans to uproot shady operators in the nursery industry, according to a 1960 news release from there. Among the targets of the campaign are certain sellers and advertisers of the ailanthus tree, also known as the "tree of heaven."

The ailanthus thrives around New York apartment buildings because it will tolerate conditions unacceptable to native trees. Outside of the city it becomes a weed tree, for its rapid growth and long, widespreading compound leaves give it a double advantage over less voracious but more desirable plants. It quickly starves and shades out native vegetation.

Yet this woody weed has been advertised in glowing terms and offered to the gullible public at $3.95. "The tree can be produced for a few cents in the nursery," the F.T.C. reports.

Another falsely advertised plant which has come under the scrutiny of the F. T. C. is an "amazing vine peach" which produces "bushels of peaches" in just a few months. Actually, the plant is a melo which bears inedible gourdlike fruits.

Potential purchasers of plants a warned by the Federal Trade Commissio to be suspicious of fabulous claims ar "tremendous" bargains; to investigate th product through local nurseries, librarie or county agricultural extension agent to check the name of the firm with th Better Business Bureau; to make su the advertiser's name and address a clearly given; to send for a catalog lis ing other plants and their prices; inquire of the advertiser as to the ag size, and grade of the plants involve and to make certain that the guarant (if one is given) is a valid one.

A green dye for lawns, called "gre plasma," has also been falsely advertise according to the F. T. C. The perso promoting and marketing it have al been required by the F. T. C. to corre their advertising for an automobile polis ing mitt, a skin food, a battery additiv and a weight reducer.

SECOND THOUGHTS ON FIBERGLAS FOR GREENHOUSES

Deterioration can be halted by new liquid plastic coating

Raphael Mutterperl

Condensed from the *American Orchid Society Bulletin*, June 1960

IN the summer of 1956 I built a steel and Fiberglas greenhouse. In May, 1957, I wrote a most enthusiastic report on it for the BULLETIN, including full instructions for "do-it-yourselfers." In September, 1959—giving the roof its annual dosing to assure maximum light for the approaching winter—I noticed that what in the previous three years had been quickly and easily effective, had little effect. The year's accumulated soot and dust just did not wash off under the pressure and volume of the garden hose. A closer examination of the roof Fiberglas showed that in three years the plastic coating overlaying the Fiberglas reinforcement had eroded—weathered away—leaving the glass fibers exposed to the elements. Since the basic Fiberglas mat is composed of innumerable small glass threads per inch, exposing these criss-crossed fibres provides a wonderful way to trap—and hold—dust and grime, just as in the Fiberglas filter in your room air-conditioner! The net effect was to reduce light transmission through the Fiberglas panels by about one-third. Was this the end of the great promise of Fiberglas as a material for greenhouse construction?

I wrote to Owens Corning Fiberglas Company, the company which makes most of the glass fibers used in making the panels but who do not themselves make panels. Their answer was that erosion and darkening of color were not only possible, but inevitable, and that the time needed to effect these changes varied with the quality of manufacture of the panels. They further advised that a new chemical preservative/restorative for Fiberglas panels had been developed which might correct the difficulty and referred me to the Durez Plastics Division of Hooker Chemical Company, North Tonawanda, New York.

Hooker Chemical Company makes "Hetrolac #105," a liquid plastic, compatible with the plastics used in making Fiberglas panels. They recommend that it be applied to new panels and renewed every three to five years. It is a clear thin fluid which goes on easily with brush or spray gun. It dries in ten or fifteen minutes. A gallon covers about seven hundred square feet to a thickness of 2 mils.

It also restores eroded Fiberglas panels. I made a test application this past winter on a strip about four feet wide and thirty feet long (as far as I could reach without getting on to the roof itself). First, I rubbed down all dirty or discolored areas (primarily, the valleys in the corrugations) with medium-fine steel wool. This was not as gruesome a job as it sounds, because the plastic is relatively softer than the steel wool. In a few swipes, the surface was smooth and clean. I then applied a coating of "Hetrolac #105" with a full brush to make sure it would flow into all the tiny crevices. In a few minutes it was dry, and my eroded Fiberglas panels looked as good as new. Hooker says this coating should last three to five years before it needs renewal.

I concede that I am treading on thin ice. It is hardly prudent to go out on a limb on the basis of a test of only a few months, to expose in public one's capacity for jumping to conclusions. Nevertheless, the virtues of Fiberglas for greenhouses are so great, in my opinion, as to warrant almost any reasonable effort to overcome its first apparent shortcoming.

WITHIN THE BOTANIC GARDEN

New gifts will bring enjoyment and understanding to millions of visitors

PICTURED here are two outstanding examples of the bonsai art for which Japan is famous. Both trees were skillfully grown and trained in the well-known bonsai nursery of Mr. Kyuzo Murata, near Tokyo, and the Botanic Garden is fortunate in being able to add them to its collection of Japanese dwarfed potted trees.

The Japanese white pine *(Pinus parviflora)*, a 40-year-old bonsai, is a gift through the fund contributed by the late Trustee Edward L. Holsten and Mrs. Holsten. It is now on display at the Garden. The trident maple (*Acer buergerianum*), a 70-year-old bonsai, is a gift to the people of New York from Mr. Yasujiro Tsutsumi, Chairman of the Board of the Seibu Railway Company. Presentation was made as part of the Tokyo-New York People-to-People program.

Like so many outstanding gifts, there is a story behind this one. The tr were first noticed in the Murata nurs by Director and Mrs. Avery when Japan last April and May, seeking f examples of bonsai. Before any w chosen, at least four visits were made Bonsai Village (where most such n series are located), outside Tokyo.

As interpreters, interested friends an or counselors and guides on one another of these trips, the Averys h Dr. Jiro Harada, Mr. Ryo Natori, M Yoshie Umiuchi, Mr. Takema Takeuc Mrs. Hatsuko Goto, Mr. Narimichi Ara and Miss Lynn Perry. To all of these, t Botanic Garden owes its thanks.

Miss Perry, able secretary to the Ag cultural Attaché in the American E bassy in Tokyo, in collaboration with h Chief, and the U. S. Department of Ag culture's Division of Plant Quarant expedited necessary final arrangeme

Presentation of the bonsai maple by Mr. Tsutsumi, its donor *(right)*, to Ambassad Douglas MacArthur II, at the American Embassy in Tokyo, in January 1961

This Japanese white pine is the year's most important single addition to the Brooklyn Botanic Garden's Holsten Collection of outstanding bonsai. The aged trident maple (*below*), presented to the people of New York by Mr. Yasujiro Tsutsumi, is shown as it appeared in leaf last May in the Murata Nursery near Tokyo. The two new gift trees were flown to the U. S. A. in January by courtesy of the Military Air Transport Service

WORTH READING

A Supplementary List of Significant Articles, Bulletins, and Books Published during 1960

Ivy and a wicket fence adorn an protect the base of a tree on one o Manhattan's east side streets. In th *New York Times* for Aug. 14, Joa Lee Faust describes some of th residential neighborhood association that are helping to keep New Yor streets attractive with appropriat plantings

ARTICLES AND BULLETINS

Gardening Techniques

Have You Considered Horticulture as a Career? Donald P. Watson. *Flower and Garden*, December. Written to encourage horticultural interest in young people.

Transplanting a 38-foot Saguaro. *Desert Magazine*, November. An astonishing feat in the successful moving of a desert giant.

Mist Propagation. Albert Lowenfels. *The Garden Journal*, May-June. A commercial technique described for the use of the amateur.

Inexpensive, Adjustable, Greenhouse Shading. Irving G. Reimann. *Cactus & Succulent Journal*, January-February. Technique of using redwood slats over a greenhouse roof.

Don't Underestimate Those Wood Chips! A. J. Perini. *Parks & Recreation Magazine*, April. Some outworn theories are scientifically disproved, and wood chips are now recommended for the soil.

What the Amateur Should Know About Fertilizers. Joseph Witmer. *The Minnesota Horticulturist*, March. A one-page, short course of basic information.

Outdoor Lighting. Stanley C. Schuler. *The New York Times*, July 3. Some useful information on adorning the garden for nighttime enjoyment, with proper warnings, both technical and artistic.

Garden Plants and Plans

Water Lilies are Easier than You Ma Think. Carroll Calkins. *House Beautifu* July. Drawings depict placement in differer kinds of pools; text gives cultural direction

Growing Annuals from Seed to Full Bloon Theodore A. Weston. *American Home*, Fel ruary. A picture story, with photographs fc every phase of every step.

Bonanza from Bulbs. *Flower Grower*, Oct ber. Photographs and text are supplemente by a chart giving planting directions, bric descriptions, and comments on 16 types c bulbs.

Beauty for Your Shady Garden. Gretche Harshbarger. *American Home*, April. Bri liantly colored photographs will tempt th reader to follow the directions given fc growing one's own plants for an area tha is sparse in sun.

Lawns, Ground Covers

Start Your New Lawn This Month. Robe W. Schery. *American Home*, August. Ph tographs depict every step from soil prepar tion to first mowing.

The Thyme Lawn. J. P. Zollinger. *Bulleti of the American Rock Garden Society*, Jul Cuttings made from two varieties of thym developed in three years into a charmin transition area between the lawn proper an the rock garden.

Trouble Control

'iseases and Insect Pests of Rhododendron id Azalea. Spencer H. Davis, Jr., and John . Libby. Extension Bulletin 345, College of griculture, Rutgers—The State University, ew Brunswick, N. J. Descriptions, illustra- ons, and control measures given for more ian two dozen troublemakers.

'ave a Weed Free Lawn! Amchem Prod- 'ts, Inc., Ambler, Pa. Practical questions id answers on the use of weed killers and i other aspects of lawn care, with illustra- ons and descriptions of 35 common weeds.

ankerworms. Neely Turner. Circular 214, onnecticut Agricultural Experiment Sta- on, New Haven. How to control these com- on pests of apple, elm, and oak trees.

Science and Research

hemical Makes Short-Stem Mums, by Al- ne Neely. *The Journal and Sentinel*, Win- on-Salem, N. C., Sept. 11. One of the ear's numerous reports on new chemicals or controlling plant growth.

hromosomes and Camellia Hybrids. E. C. ourjé. *Camellian*, January. An up-to-date st of chromosome numbers of Camellia spe- es and hybrids, with introductory text.

n Outer Space Garden. Samuel P. John- n. *The Garden Journal*, May-June. Re- earch by Boeing Aircraft on plants for food id oxygen supply when men are shot into pace.

Cities and Their Plants

ir Pollution Headache Grows—Now Cov- ing Large Urban Areas. Robert H. Daines. *lorists Exchange*, Dec. 17 and 24. How ant life suffers from air pollution ex- ained, giving specific effects on different kinds of plants of gases from automobile traffic and other by-products of urban living.

Ecology of Cities. Karl Linn. *Landscape Architecture*, Fall. Seven aspects of the domain of landscape architecture and seven problems faced in planning urban plantings.

Some New Street Tree Trends. Paul Tritenbach. *Parks & Recreation Magazine*, March. Useful ideas for city planners.

Conservation, Nature

The Walden Decision. *Landscape Architecture*, Fall. How the remnants of the area made famous by Thoreau finally were saved by the Massachusetts Supreme Court from complete destruction through an attempt to build a bathing beach resort on the shore of Walden Pond. Replacing of felled trees was one of the requirements imposed on the encroachers.

The Adventure Approach to Conservation Teaching. Arthur W. Silliman. *The New York State Conservationist*, February-March. Mr. Silliman describes methods used successfully for many years in teaching grade-school pupils about natural resources, and in guiding them so that they can "relate books to life as they see it."

Some Common Edible and Poisonous Mushrooms of Pennsylvania. Charles L. Fergus. Bulletin 667, Agricultural Experiment Station, University Park, Pa. Excellent photographs of the more than forty species treated complement the informative text.

Landscape Plants that Attract Birds. G. William Longenecker and Robert Ellarson. Circular 514, University of Wisconsin Extension Service, Madison. Pictorial tables and text give landscaping ideas, living requirements of birds, a choice of plants and cultural notes.

BOOKS

Special Groups of Garden Plants

ontemporary Perennials. Roderick W. Cumming and Robert E. Lee. 363 pages, illustrated by Allianora Rosse. Macmillan, New ork. $6.95.

Five hundred species are treated; a quarr of these, in 100 different genera, illustated. There are also useful lists.

he Orchids: A Scientific Survey. Carl L. ithner, editor. 648 pages, illustrated. Rond Press, New York. $14.

A technical treatment of orchids and orchid research, written by fifteen specialists. The editor, Dr. Withner of Brooklyn College, is also the specialist in charge of the orchid collection at the Brooklyn Botanic Garden. Chapters on history, classification, anatomy, cytology, reproductive processes and seed production, geography, hybridization and inheritance, physiology, mycorrhiza, photoperiodic and temperature responses, pests and diseases, and "Vanilla—the orchid of commerce" each have a bibliography.

The 120-page appendix includes a taxonomic key to the tribes and subtribes; a list of chromosome numbers of some 800 species and varieties, and smear techniques for making counts; orchid culture media and nutrient solutions. Comprehensively indexed.

The Cultivated Palms, a special issue of *The American Horticultural Magazine* (the journal of the American Horticultural Society, Inc.), issued in December 1960 under date of January 1961.

Produced with the assistance of The Palm Society, this publication, virtually a book of 189 splendidly illustrated pages, contains basic information on the distribution, classification, culture, and uses of palms.

Getting Started with Rhododendrons and Azaleas. J. Harold Clarke. 268 pages, illustrated. Doubleday, Garden City, N. Y. $4.95.

A good primer for the beginner.

Rhododendrons and Azaleas, second edition. Clement Gray Bowers. 525 pages, illustrated in color and black and white. Macmillan, New York. $25.

Up-to-the-minute in nomenclature and cultural practices, this is at the same time styled for easy use by the amateur. Two new color plates by the author depict choice species and hybrids recently introduced.

Anyone Can Grow Roses, third edition. Cynthia Westcott. 197 pages. Van Nostrand, Princeton, N. J. $3.75.

"Truly, *Anyone Can Grow Roses* with a little love and land where the sun shines part of the day," says the author in introducing her 1960 edition, which she has rounded out with experiences of recent years. "The love is necessary," she adds, saying further, "The problems of rose growing are insignificant compared to the rewards."

How to Grow Roses (a Sunset book), second edition. J. Paul Edwards. 88 pages, illustrated. Lane, Menlo Park, Calif. $1.75.

The concise instructions on selection, growing, propagating, and exhibiting make this a good working manual for the beginner.

Rose Pruning with Pictures. M. M. Thompson. 56 pages, illustrated. Paper cover. Mary Lynn & Associates, Los Angeles, $1.

Close-up photos show different methods of rose pruning.

Iris for Every Garden, revised edition. Sidney Mitchell. Revised by Molly Price. Foreword by F. W. Cassebeer. 216 pages, drawings, photographs, five color plates. Barrows, New York. $4.95.

Culture and uses of each iris group, w chapters on general culture and breedi New material on dwarf irises, also on bre ing methods and disease control added.

The Iris. N. Leslie Cave. 240 pages, il strated, partly in color. St. Martin's Pr New York. $7.50.

A comprehensive book, including habi maps of each species, and information ab the better known hybrids, with a chapter hybridizing for the beginner.

Irises for Everyone. N. Leslie Cave. pages, illustrated. Faber & Faber, Lond 10/6 ($1.50).

A small book with some good lists different kinds of iris.

All About Begonias. Bernice Brilmayer. pages, drawings, photographs, and four co plates. Doubleday, Garden City, N. Y. $4.

An amateur writes for other amateurs

The Evergreens. J. H. Beale. 285 pag line drawings, photographs by outstand horticultural photographers, and five co plates. Doubleday, Garden City, $4.50.

How to select, place, plant, maintain, a propagate needle-leaved and broad-lea evergreens, told with authority.

Decorative Trees and Shrubs. 62 pages, color plates by Hans Schwarzenbach. Vik Press, New York. $20.

Full-page drawings in color, with descr tive and cultural information.

Palms of the World. James McCurra 290 pages, illustrated. Harper, New Yo $17.50.

An extensive pictorial treatment with t by an amateur palm enthusiast.

An Illustrated Reference on Cacti and Ot Succulents, Vol. 2. Edgar Lamb. Blandf Press, London. 45/- ($6.30).

An easy guide by which to recognize cac and succulents.

Lawns. R. B. Dawson. 169 pages. Pa cover. Penguin, Baltimore, Md. $1.45.

A small book filled with useful infor tion clearly described, though American ho owners may find some of the English te confusing.

Sunset Lawn and Ground Cover Book. J seph Williamson, editor. 96 pages. Pa cover. Lane, Menlo Park, Calif. $1.75.

Largely for the California climate. Th are numerous illustrations and charts, w clear directions for planting and care.

Gardening in General

w Illustrated Encyclopedia of Gardening. H. Everett, editor. 14 volumes, about 00 pages, illustrated in color and black l white. Greystone Press, New York, 50. $51.

The first major encyclopedia to appear m the American press since "The Stand- l Cyclopedia of Horticulture" by L. H. iley, which was last revised a generation). Compiled with the interests and prob- ıs of the amateur gardener in mind.

dget Landscaping. Carlton B. Lees. 152 ges, illustrated. Holt, Rinehart & Wins- , New York. $3.95.

Analysis of the home landscape, a time- le for year-by-year development of plant- plans, and before-and-after drawings.

cyclopedia of Gardening. Stanley B. itchead. 789 pages, illustrated. Bran- d, Newton Centre, Mass. $5.

Originally published in Britain and most ful to British gardeners.

e Golden Garden Guide. John Strohm, tor. 176 pages, illustrated. Paper cover. lden Press, New York, $1.

Sections on every aspect of home garden- : lawns, trees and shrubs, flowers, house nts, tools and machinery, and other ies.

w to Improve Your Home by Landscap- . Barbara Baer. 64 pages, illustrated. per cover. Equitable Life Assurance So- ty, New York. Free.

Right and wrong methods shown in many the pictures.

uides for Traveling Gardeners

e Gardener's Directory. J. W. Stephen- . 454 pages. Hanover House, New York. 95.

Besides lists of horticultural organizations the United States and ninety other coun- es, this guide tells the traveler what he t see of horticultural interest every- ere. Botanical gardens, nurseries, horti- tural publications, garden centers, and vernment agencies, are all listed sepa- ely.

Pictorial Guide to American Gardens. uis E. Frohman and Jean Elliott. 364 pages, 400 illustrations, 90 in full color. Crown, New York. $5.95.

A guide to 1,500 gardens in the United States that are considered worth visiting.

Tropical Blossoms of the Caribbean. Dorothy and Bob Hargreaves. 64 pages. Paper cover. Hargreaves Industrial, Portland, Oregon. $2.

More than 100 color reproductions of flowers of the Bahamas, the Caribbean area, the West Indies, and the tropical parts of South America, with interesting paragraphs on each plant.

Arts, Crafts, and Projects

Bonsai: Japanese Miniature Trees. Kan Yashiroda. 166 pages. Branford, Newton Centre, Mass., $5.75.

Sixteen chapters on bonsai style, cultivation, and training. A comprehensive presentation, with numerous descriptive diagrams and more than 100 splendid halftones. Definitely one of the best books available on the subject.

Japanese Flower Arrangement: Classical and Modern. Norman J. Sparnon. 264 pages, 100 full-page color plates, 115 black and white illustrations; photographs by Miki Takagi. Tuttle, Rutland, Vermont. $15.

Fifteen lessons in the basic styles: old classical, classical, modern, and avant-garde, with historical summary and treatment of symbolism.

Simplified Flower Arrangements. Patricia Easterbrook Roberts. 136 pages, illustrated, partly in color. Viking (Studio), New York. $5.

Easy-to-make arrangements with readily available flowers.

Japanese Flower Arrangement for American Homes. Mary Badham Kittel. 167 pages, illustrated, partly in color. Viking (Studio), New York. $6.95.

A section for each classical style with adaptations for both temporary and permanent arrangements.

Decorating with Seed Mosaics, Chipped Glass, and Plant Material. Eleanor Van Rensselaer. 214 pages, illustrated in color and black and white. Van Nostrand, Princeton, N. J. $5.95.

How skillful fingers can achieve artistic results with unusual combinations of material.

The Driftwood Book. Mary E. Thompson. 200 pages, illustrated. Van Nostrand, Princeton, N. J. $5.95.

Flower arrangements and other decorative pieces made with driftwood as the inspiration or the basic material.

Chrysanthemums Indoors. Vera Todd Baxter. 92 pages, illustrated. Hearthside, New York. $3.50.

Devoted chiefly to flower arrangement.

Corsage Craft, second edition. Glad Reusch and Mary Noble. 189 pages, illustrated. Van Nostrand, Princeton, N. J. $4.95.

Judging techniques and standards at flower shows included.

Therapy through Horticulture. Donald P. Watson and Alice Burlingame. 134 pages, illustrated. Macmillan, New York. $4.95.

Two leaders describe methods and results in working with individuals and groups in hospitals, homes, and institutions.

The Book of Planters. Robert Scharff. 191 pages, illustrated. Barrows, New York. $3.50.

Describes all kinds of containers for growing plants; how to use and make them.

Handbook of Plant and Floral Ornament from Early Herbals. Richard G. Hatton. 539 pages, illustrated. Paper cover. Dover, New York. $2.98.

Original edition titled: *The Craftsman's Plant Book: or Figures of Plants.* Contains remarks on use of plant form in design.

Sunset Garden and Patio Building Book. Lane, Menlo Park, Calif. $6.95.

A hard-bound volume composed of five previous Sunset books: Sunset Patio Book, Garden Work Centers, How to Build Patio Roofs, How to Build Fences and Gates, and Walls, Walks and Patio Floors.

Nature, Conservation

Trees, Shrubs, and Woody Vines of the Southwest. Robert A. Vines. 1,104 pages, illustrated with drawings by Sarah Kahlden Arendale. University of Texas Press, Austin. $25.

More than 1,200 species of native and naturalized woody plants found in Texas, New Mexico, Oklahoma, Arkansas, and Louisiana. The range extends from subtropical to high mountain areas.

Hawaiian Flowers and Flowering Tre Loraine E. Kuck and Richard C. Ton 158 pages, more than 140 illustrations full color. Tuttle, Rutland, Vermont. $2.

A paper-bound edition of a fine and us ful book on the ornamental woody plan of our Pacific state.

A Handbook of British Flowering Plan A. Melderis and E. B. Bangerter. 360 pag Abelard-Schuman, New York. $10.

Copiously illustrated work (many spec in color) on British wild flowers and tre

Nature in the Metropolis; Conservation the Tri-State Metropolitan Region. Willi A. Niering. 64 pages, illustrated. Regio Plan Association, 230 West 41st Street, N York 36, N. Y. $3.

With its excellent photographs this gi an alluring view of what the region arou New York can offer in fine natural scene Every city planner and commercial develo whose project would destroy an irreplaceal landscape should digest this book bef putting his plans on paper.

This Land of Ours. Alice Harvey Hubba 272 pages. Macmillan, New York. $4.95.

From every state and several forei countries the stories of successful proje in conservation and community beautifi tion have been assembled for this bo The general method of procedure is th outlined as a guide for organizations ai ing to improve surroundings.

The New Handbook of Attracting Bir Thomas P. McElroy, Jr. 184 pages, ill trated. Knopf, New York. $4.

A complete revision of an earlier wo based on ecological principles of bird ma agement.

The Grasses: Earth's Green Wealth. Al Chesnut Moore. 150 pages, illustrated Mel Hunter. Macmillan, New York. $5.

Dune grasses of northeastern seasho giant bamboos of tropical forests, co wheat, rice, and other food grains, sorghu and sugar cane are presented from the po of view of man's history, economy, a future.

Living Insects of the World. Alexander a Elsie Klots. 304 pages, illustrated with 2 photographs, including 152 in full col Doubleday, Garden City, N. Y. $9.95.

Descriptive text covers behavior, life cyc habitats and other information on inse from the Canadian Arctic to tropical Afri

sing Wayside Plants, third edition. Nelson
. Coon. 254 pages, illustrated. Hearthside,
ew York. $3.95.

Information on practical and interesting
ses of about 100 plants found growing
ild along the side roads and highways of
ie eastern half of the United States.

960 Conservation Directory. 121 pages.
aper cover. National Wildlife Federation,
412 16th St., N.W., Washington 6, D. C.
)¢.

A list giving names, addresses, and tele-
one numbers of government departments
id officials, also citizens' organizations,
ncerned with natural resources.

For the Younger Generation

tate Trees. Olive L. Earle. 62 pages, illus-
ated. Morrow, New York. $2.50.

Nature and habits of each tree described.

ow to Grow House Plants. Millicent E.
lsam. 96 pages, illustrated. Morrow, New
ork, $2.50.

While written for children between the
es of 10 and 14, it has a directness equal-
appropriate for adults.

reatures of the Night. Dorothy Sterling.
3 pages, illustrated. Doubleday, Garden
ty, N. Y. $2.95.

An excellent account of insect life at
ght, with much additional natural history.

On the Technical Side

ant Disease Handbook, second edition.
nthia Westcott. 825 pages, illustrated.
n Nostrand, Princeton, N. J. $13.50.

More than 2,000 plant diseases and 1,000
st plants are included, with means of
entification and proper treatments in the
ht of recent research findings.

inciples of Plant Breeding. R. W. Allard.
5 pages, illustrated. Wiley, New York. $9.

Comprehensive and thorough work on
e subject, suited for college-level study.

Diseases and Pests of Ornamental Plants, third edition. P. P. Pirone, B. O. Dodge, and H. W. Rickett. 775 pages, illustrated. Ronald Press, New York. $10.

An opening section on diseases and pests in general and methods for their control precedes a comprehensive 600-page alphabetical treatment, plant by plant.

The Soil and Its Fertility. H. Teuscher and R. Adler, with the collaboration of Jerome P. Seaton. 446 pages. Reinhold, New York. $12.

This book gives an uncommonly lucid explanation of the ingredients of soil and of added fertilizers, of the laws of soil fertility, and of recommended methods.

Index of Plant Diseases. U. S. Department of Agriculture, Agricultural Research Service, Crops Research Division. 531 pages. U. S. Government Printing Office, Washington, D. C. $3.75.

A bound volume to replace the reports by the same title, originally issued 1950-1953.

Food. Yearbook of Agriculture, 1959. U. S. Department of Agriculture. 736 pages, illustrated. U. S. Government Printing Office, Washington, D. C. $2.25.

Cultural practices that affect food quality make up an important part of this volume.

Vegetable Diseases and Their Control. Charles Chupp and Arden F. Sherf. 693 pages, illustrated. Ronald Press, New York. $12.

A reference work particularly for commercial growers in temperate and tropical regions.

A Thousand Answers on Pest Control. 89 pages, illustrated. Paper cover. Acme Quality Paints, Inc., Detroit. $2.

Precise directions in tables, text and illustrations.

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Summer Issue, Gardens of Western Europe, pages 1–96
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